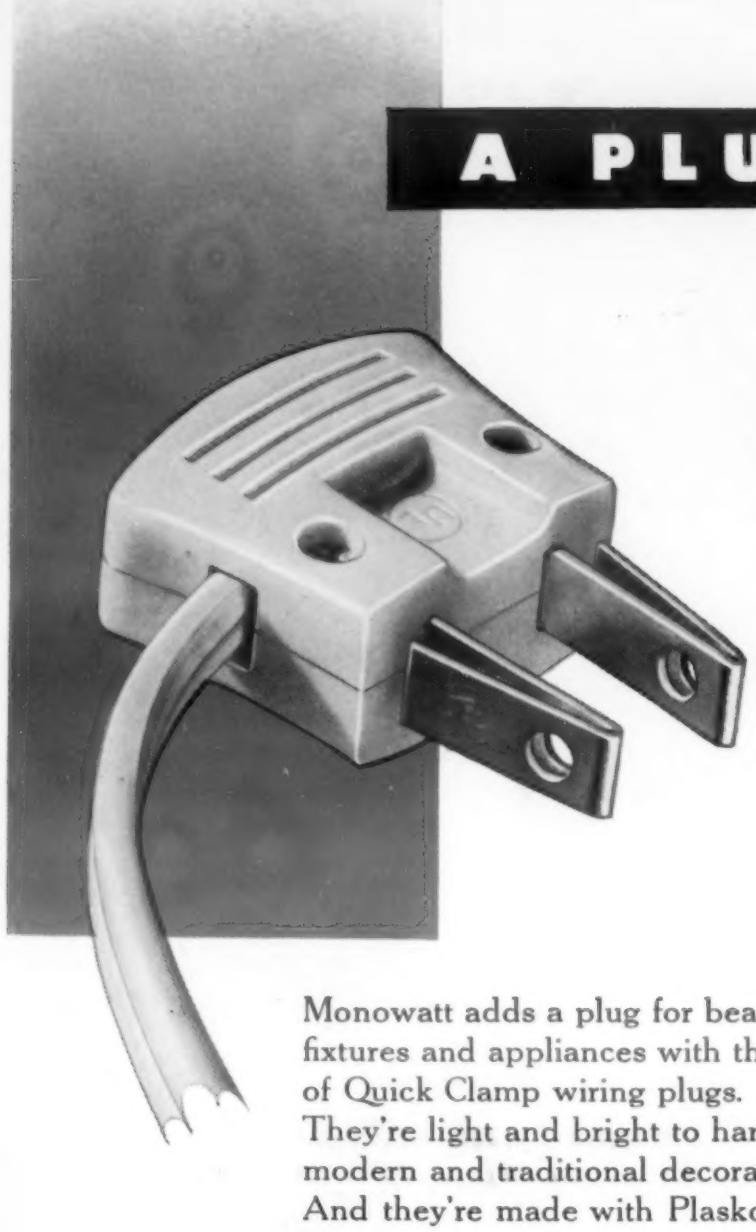
Materials & Methods

THE MAGAZINE OF MATERIALS ENGINEERING

July 1950



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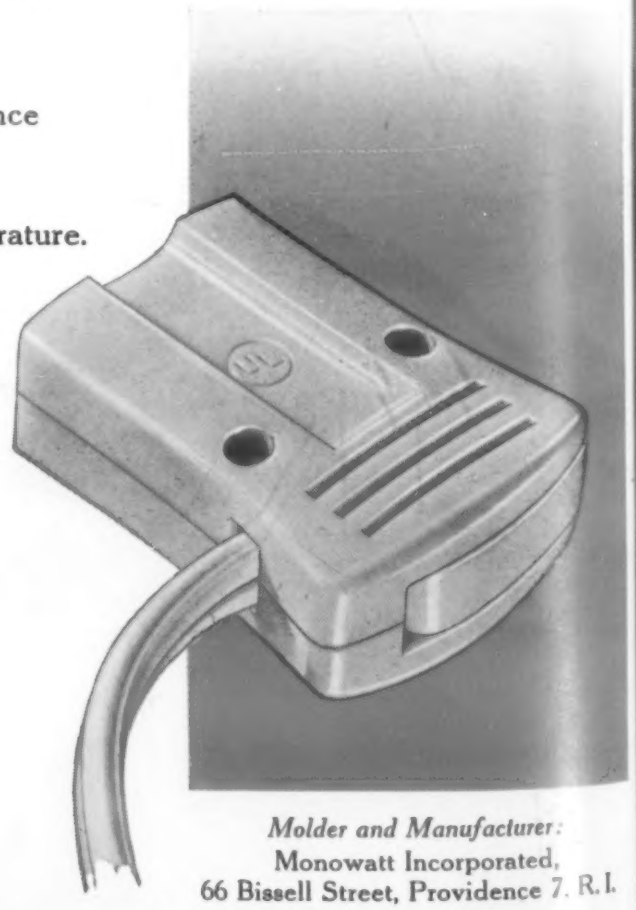

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Index of Feature Material

MATERIALS & METHODS

Volume 32

July—December 1950, Inclusive

Feature editorial matter from Volume 32 of MATERIALS & METHODS covering issues from July through December 1950 is indexed here. Material covered in the index includes feature articles, MATERIALS & METHODS Manuals, and Engineering File Facts.

Authors' Index

Materials & Methods®

THE MAGAZINE OF MATERIALS ENGINEERING

VOLUME 32, NUMBER 1 — JULY 1950

FEATURE ARTICLES

ENGINEERING FILE FACTS

DEPARTMENTS

NEXT MONTH: Engineering Properties of Felt . . . Flame Hardening . . . Polishing with Diamond Powder Abrasive . . . "C" Casting Process . . . Repair Welding Cast Iron . . . New Abrasion Resistant Finish for Aluminum . . . EXTRUDED METAL SHAPES (Materials & Methods Manual No. 61)

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The Materials Outlook

hile the prices of many metals are rising, such increases are
ot with the reckless abandon of last year and the year before. . . .
oo many producers realize that there is a good chance of pricing
hemselves out of sizable markets. . . . Copper, zinc and lead
ould be included in that group. . . . There has been resistance
o a general price increase in steel. Certain producers have
aised prices, and some specific products cost more, however.

The recent 8-cent per lb. boost in nickel prices is likely to have an effect before long on the cost of stainless steels. Stainless steels have nickel contents ranging from 1.25 to 22.0%.

ast year steel shortages were concentrated in sheet and light
late. Efforts of the steel industry, despite strikes in their
wn and the coal industry, largely overcame this shortage.
owever, shortages then developed -- and are still with us --
n rod, bar stock and some tubes. Even though operations are
till above 100% of rated capacity, steel spokesmen see no
mmediate balance between supply and demand.

Stainless steel demand, which has climbed steadily in the postwar era, is now getting further stimulus in the building field. Insulated stainless steel curtain walls were used in a recently completed warehouse. The wall is made of steel panels with stainless steel facing and weighs 6 to 10 lb. per sq. ft., as compared to 100 to 175 lb. per sq. ft. for masonry walls.

roduction and consumption of aluminum are both at an all-time
igh. Despite a steady increase in peacetime productive capacity,
ew uses for the metal in plate, sheet and strip keep demand
head. New reduction and rolling mills put into operation
uring the past month may help.

As an example of new uses of aluminum, the Federal Department of Commerce reports on "front surface mirrors" with aluminum reflecting surfaces. Evaporated aluminum is better suited as a reflecting surface than silver because of finer grain, smoother surface and good adherence to the mirror base.

ertain plastics have recovered from a serious slump which
eveloped during the last half of 1949. Now, in the case of at

(Continued on page 4)

The Materials Outlook *(Continued)*

least two types -- namely vinyls and styrenes -- allocations are a distinct possibility because demands are beginning to exceed supplies. In fact, the demand for styrenes is having an effect upon the manufacture of synthetic rubber, since certain types have common roots.

> Typical of the way certain materials are being applied in unusual ways is the use of high-chromium stainless steels for television tubes. Stainless steels of the type being used are selected because of their coefficient of expansion, which closely matches that of glass. However, these steels are not considered suitable for forming. Nevertheless they are being spun into cones and probably will be deep-drawn into rectangular shapes for the latest type of tube.

Increased activity in the field of cold extrusion of steel is expected as a result of a visit here of German experts in the field. An interested party is a company with a long experience in the field of phosphate coatings. The secret of cold extrusion of steel is said to be in the lubricant used, and phosphates are the basis for several such lubricants.

> Further use of aluminum in applications where abrasion is a factor can be expected in a new development that will deliver all it promises. A large aircraft company has developed a hard coating for aluminum which is said to provide wear resistance superior to that of case-hardened steel. Parts already so treated include gears, pinions, impeller blades, hand tools, and many others. The coating is applied electrochemically and has a thickness of from 0.0001 to 0.006 in.

The production of shapes in steel by hot extrusion is also coming in for considerable attention. Unconfirmed rumors indicate that a major steel company in this country is extruding stainless steel. One of the greatest problems is in finding die steels that will withstand the heat and pressure needed to form steel shapes by this method. Of these, heat resistance is of more importance.

> Rapid increases in raw materials costs of metals is inviting foreign competition. In a recent 10-day period 27,000 tons of pig iron were imported. Scrap imports also promise to reduce the pressure for steel price rises for some time to come.

The continuing uses of lithium compounds in greater quantities is reflected in a 10% reduction in price, effective July 1. Lithium is used in ceramics, porcelain enamels, welding fluxes, and as atmospheres for heat treating.

News Digest

Zinc Alloy May Compete with Brass

A zinc alloy having approximately the same strength and electrical characteristics as brass has been developed by R. H. Harrington of General Electric's Research Laboratory. The springy, resilient alloy contains small quantities of copper and beryllium and is considerably cheaper than brass.

Called "Zncube" (pronounced "zin-cue-be") from the chemical symbols for its composition, the alloy is said to have about eight times the useful strength of any zinc alloy now in use. It is also claimed to be easily machined, soldered and resistance-welded.

Possible applications for Zncube, still in the development stage, are lamp and fuse sockets and bases, panels, containers, mild springs, and many other forms of hardware now made of brass.

Output of Pure Aluminum Sheet Up

"Super purity" (99.99%) aluminum sheet is now being produced in large quantities by The British Aluminum Co., Ltd., for use in flashings for the building industry.

Increasing costs of copper, lead and zinc, and doubts about long-term availability of lead, have encouraged the development of alternative materials, particularly for use in flashings, weatherings and gutter linings. Difficulties encountered because of lack of ductility (compared to lead) in normal commercial-purity aluminum have been eliminated by the new high-purity sheet.

Casting Alloys, Methods Discussed by Foundrymen

The 54th annual meeting of the American Foundrymen's Society was held May 8 to 12 in Cleveland. Among the highlights of this meeting, most important conference of the year for the foundry industry, were the annual Gold Medal awards and honorary life memberships, and a variety of technical papers on the properties of casting alloys.

The Wm. H. McFadden Gold Medal went to Dr. Richard Schneidewind, University of Michigan, and the Joseph S. Seaman Gold Medal to Dr. Clarence H. Lorig, Battelle Memorial Institute. Honorary life memberships were awarded to Dr. Ralph L. Lee, General Motors Corp.; Clyde L. Frear, Bureau of Ships; and Edwin W. Horlebein, retiring president of the American Foundrymen's Society.

The papers of particular interest to M&M readers dealt with new alloys, the properties of castings as influenced by various foundry techniques, and relationships between the properties of castings and composition or different mechanical test results. Some of these papers are summarized briefly below.

Aluminum Casting Alloys

Two new aluminum alloys, one for sand casting and the other for permanent-mold casting, were described in a paper entitled "New Aluminum-Zinc-Magnesium-Copper Casting Alloys," presented by W. E. Sicha and H. Y. Hunsicker, Aluminum Co. of America. The sand casting alloy, designated A612, has the nominal composition: 6.5 zinc, 0.7 magnesium, 0.5 copper and 0.15% titanium. The alloy designated C612, containing 6.5 zinc, 1.0 iron, 0.5 copper, 0.35 manganese and 0.10% titanium, has enough resistance to hot cracking to permit production in permanent molds of castings that are not extremely intricate in design.

Good combinations of tensile properties for non-heat-treated aluminum alloys are produced in these alloys by natural aging. A suitable artificial aging treatment can be applied to alloy A612 for more rapid attainment of specified tensile properties. Thus, natural aging for seven days may give 35,300 psi. tensile strength, 20,200 psi. yield strength, 9.0% elongation in 2 in., and 69 Brinell hardness. Aging 8 hr. at 350 F, following a solution treatment of 4 hr. at 970 F and water quench, may give 39,900 psi. tensile strength, 34,500 psi. yield strength, 5.0% elongation in 2 in. and 85 Brinell hardness.

Typical Properties of New Alloys
(Aged 30 Days at Room Temperature)

Property	A612	C612
Tensile Strength, Psi.	35,000	35,000
Tensile Yield Strength (0.2% Offset), Psi.	25,000	19,000
Elongation (% in 2 in.)	5.0	8.0
Brinell Hardness	95	70
Compressive Yield Strength (0.2% Offset), Psi.	25,000	—
Shearing Strength, Psi.	26,000	—
Endurance Limit (500 Million Cycles), Psi.	8000	—
Electrical Conductivity @ 77 F (% of Cu.)	35	40
Thermal Conductivity @ 77 F, Btu./hr./ft.²/ft./deg. F	80	92
Coefficient of Thermal Expansion, per deg. F	13.4×10^{-6}	—
Specific Gravity	2.81	2.84

Standard accelerated tests have shown these alloys to be resistant to corrosion and stress-corrosion crack-

News Digest

ing. Both alloys exhibit excellent brazing characteristics and are used for castings in brazed assemblies. Mechanical properties and resistance to corrosion are not impaired by conventional brazing treatments at temperatures up to 1120 F, and are satisfactory after elevated temperature treatments which may be employed for aging wrought components of brazed products.

Surface Hardening Malleable

What is apparently the first systematic investigation of the response of pearlitic malleable irons to surface hardening was made by S. H. Bush, W. P. Wood and F. B. Rote, University of Michigan. In their paper "Surface Hardening of Pearlitic Malleable Irons," results were presented for nine different irons exhibiting wide differences in chemical composition, production practices and microstructures.

Flame and induction heating, followed by oil, water or spray quenches were used for the surface hardening treatments. Frequencies used in induction heating were 3000, 9600 and 300,000 to 347,000 cycles. Case hardness and depth were determined by superficial Rockwell C measurements and metallographic examination of etched specimens.

On the basis of a hardness of 50 Rockwell C at a minimum depth of 0.060 in., eight of the pearlitic malleable irons investigated could be satisfactorily induction hardened with

(Continued on page 98)

New Phosphorus-Containing Alloys Give Bright, Hard Electrodeposits

A commercially feasible method for producing electrodeposits of cobalt or nickel alloyed with as much as 15% phosphorus has been developed at the National Bureau of Standards and is described in Technical Report 1441.

In addition to providing hard, corrosion resistant and bright coatings, the new phosphorus alloys are more easily deposited than chromium. For this reason they are expected to be useful for many applications where chromium plate is now used for a hard, wear resistant surface or a decorative finish.

Appearance of Deposits

Appearance of the deposits depends upon their phosphorus content. Alloys with less than 2% phosphorus are usually smooth with a mat finish; but as the percentage of phosphorus increases, they become brighter, reaching a peak of brightness at a phosphorus content of about 10%. When such deposits are plated on a dull surface, they increase in brightness as they become thicker. As a result of the slightly dark cast of the high-phosphorus alloys, their reflectivity is only 45 to 50%, compared with about 60% for buffed nickel coatings.

When some of the phosphorus alloys are immersed momentarily in a solution of an oxidizing agent, such as ferric chloride, or made anodic in the plating bath, a jet black film is formed on the surface of the metal. This film is hard and adherent, and appears to have possibilities for decorative use.

Properties of Deposits

Hardness of the deposits as plated varies from 350 to 720 Vickers, increasing with phosphorus content. When the alloys are heat treated at 750 F, they become much harder. For example, a heat treated cobalt-phosphorus deposit containing about 10% phosphorus reaches a hardness of over 1100 Vickers, which is greater than that of electrodeposited chromium. Deposits that have been heated as high as 1470 F and cooled are not appreciably softer than the initial deposit. However, the alloys have poor "hot hardness," and above a temperature of 1100 F are softer than unalloyed nickel or cobalt.

Although the low-phosphorus alloys become ductile after heat treatment at 1470 F, deposits containing more than 1% phosphorus are generally brittle. Alloys with higher percentages of phosphorus are highly resistant to corrosion and chemical attack—more so than the pure metals.

Plating Bath Characteristics

Plating baths for depositing these alloys are fairly simply prepared, consisting of common nickel or cobalt salts to which is added phosphorus acid. Phosphoric acid is used as a buffer. The bath is kept at a low pH —between 0.5 and 1.5—and a temperature of 165 F or above. At the usual current density of about 10 amp. per square decimeter, the rate of deposition amounts to a few thousandths of an inch an hour.

The more rapid rate of deposition as compared with chromium and the better throwing power of the bath are expected to be of commercial advantage. Although the phosphorus alloys are not as white as bright nickel, operation of the baths is much less critical than for proprietary bright nickel. The phosphorus alloys can be plated from a bath made up entirely of inorganic chemicals, whereas bright-nickel plating solutions must contain an organic brightening agent.

Spring Brass Stumps Metallurgists

One of the large users of brass springs is studying a phenomenon that appears to be useful but hard to explain. Cartridge brass spring stock, rolled four B&S numbers or more, increases substantially in yield strength if held at 300 F for some hours. Thus, springs can be formed in this low-cost metal at a relatively low temper and then hardened—if the process is reliable and controllable. More research will be done before commercial application is considered practical.

Meanwhile, the metallurgists are puzzled as to why simple brass seems to behave like an age-hardening alloy.

New Die Casting Alloy Developed

Development of a new aluminum die casting alloy with high yield strength was reported recently in *Metal Progress,* May, 1950, by J. J. Warga, J. J. Preisler and S. B. Ashkinazy, of Sperry Gyroscope Co.

The material is being used in a gimbal ring, a bracket used to support a spinning gyroscope. Available aluminum die casting alloys had insufficient yield strength, so the problem was solved by adding silicon to an aluminum-magnesium-zinc alloy previously used for investment castings.

Called Sperry Alloy 37, the new material contains 4.3 silicon, 1.8 magnesium, 3.5 zinc, 0.1 copper, 0.2 chromium, 0.3 iron, 0.4 manganese, 0.03 nickel and 0.07% titanium.

High Temperature Materials Hold National Spotlight

News Digest

New developments in high temperature materials were of considerable interest at two important technical meetings held in April. Some of these papers, presented to the Electrochemical Society in Cleveland and the American Ceramic Society in New York, are briefly summarized here.

Refractory Oxides and Carbides

Results of an investigation of "Some Physical Properties of Eight Refractory Oxides and Carbides" for possible gas turbine application were reported to the ceramists by James J. Gangler, National Advisory Committee for Aeronautics. Compositions included beryllium oxide, magnesium oxide, stabilized (6% lime) zirconium oxide, zircon, boron carbide, 85% silicon carbide plus 15% boron carbide, titanium carbide and zirconium carbide. Properties determined were short-time tensile strength at elevated temperatures, thermal-shock resistance, coefficient of thermal expansion and density.

Zirconium carbide had a short-time tensile strength of 15,850 psi. at 2200 F, the highest measured at this temperature; however, it exhibited poor resistance to oxidation. Boron carbide had a short-time tensile strength of 22,550 psi. at 1800 F, the highest at this temperature. Evaluation of the strength of boron carbide at 2200 F was unsuccessful. Boron carbide also had poor oxidation resistance and was among the worst materials investigated in its ability to resist fracture by thermal shock.

Titanium carbide had the best resistance to thermal shock and was the most promising of the light compositions investigated. It had strengths of 15,850 psi. at 1800 F and 9400 psi. at 2200 F. Hot-pressing of these bodies indicated that a density of at least 93% of theoretical density could be obtained.

Cermets for Cathodes

In "Refractory Cermets," L. J. Cronin, Raytheon Manufacturing Co., described an investigation conducted to determine the suitability of refractory materials for use in special thermionic cathodes. These cathodes are made from a mixture of oxides and metal powders. Unlike other cathodes, these cermet bodies can be brought to elevated temperatures by impressing a voltage directly across the terminals. Resistivity can be varied at will by processing and composition control.

Requirements for the cermets are severe. Melting point of the body must be greater than 3270 F and operation conditions demand low vapor pressure, chemical stability, adequate thermionic and secondary electron emission, hot strength, and other factors that will allow proper performance in a vacuum device. In addition, the selected materials must lend themselves to fabrication by powder metallurgical methods and subsequent assembly. All available substances were tested and satisfactory cermet bodies were developed to meet these requirements. One of the most satisfactory materials contained 80 thorium oxide and 20% molybdenum.

Oxide-Metal Materials

L. D. Howrer, Jr., F. G. Veltz and J. W. Londeree, Jr., Rutgers University, investigated "High Temperature Bodies in the System MgO-TiN-NiO." These components are united in a chemical bond which is continuous between the oxide and metallic phases. Titanium nitride is introduced to serve as a bonding medium through solution or by wetting. Nickel oxide is reduced to nickel metal during the firing operation, providing better metal distribution than does the addition of powdered nickel metal.

Some properties of several of these bonded oxide-metal bodies have been evaluated. Thus, the density of these bodies is approximately one-half that of metals. Transverse strength of several bodies is comparable to a majority of the refractory oxides and, upon oxidation, has been observed to increase as much as 50%. Thermal shock resistance appears to be good, but final appraisals will have to be made with larger specimens.

A "Fundamental Study of Simple Metal-Ceramic Mixtures in Air at High Temperatures" was discussed by V. D. Fréchette and his Navy Project Staff, New York State College of Ceramics. Their studies have covered a variety of binary mixtures of cobalt,

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REPUBLIC Alloy Steels

A REPORT FROM REPUBLIC STEEL'S *alloy* METALLURGICAL FILES

Photo courtesy The S. M. Jones Co., Toledo, Ohio

3 DIMENSION *Metallurgical Service*

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Materials & Methods
JULY 1950

How to Fabricate Molybdenum

Most of the methods and techniques used in forming, machining, joining and finishing this increasingly important metal are conventional and can be mastered without too much difficulty.

by **JACK CHELIUS**, Fansteel Metallurgical Corp.

• AS THE FIELD FOR high temperature parts has expanded, the need for new structural metals has become increasingly apparent. Several high melting materials, previously considered "minor metals," have been recently developed to the point where they now show considerable promise as useful engineering materials. One of these metals is molybdenum.

Compared with other present-day metals, molybdenum has superior strength at temperatures above 1900 F, as well as a high modulus of elasticity (almost 70% higher than that of steel). As with other metals, however, inherently favorable properties are of use only if fabrication problems are not too difficult.

It is with this important factor in mind that this article has been prepared. In this article, the forming, machining, joining and surface finishing characteristics of molybdenum will be discussed. A thorough knowledge of the possibilities and limitations of fabricating processes as applied to molybdenum is a necessary prerequisite to the development of practical applications for this useful metal.

Forming

Most of the procedures in working and fabricating molybdenum are conventional, and can be mastered without too much difficulty. At the outset, however, one important characteristic of molybdenum must be kept constantly in mind; molybdenum should never be formed or bent in a chilled condition. Where the term "room temperature" is used in this article, a temperature of 70 F or more is meant. A few simple tests will quickly convince the reader of the substantial difference in workability caused by the slight difference between 40 and 70 F.

The lighter gages of molybdenum sheet, less than 0.020 in. in thickness, can be formed easily at room temperatures. Cross-rolled molybdenum sheet in this range of thicknesses can be bent to an angle of 180 deg. in any direction on a radius equal to its thickness. When material between 0.020 and 0.040 in. thick is formed, the sheet should be warmed to a temperature of 200 to 325 F. Sheet heavier than 0.040 in. should be worked at 900 to 1000 F to avoid cracking.

Punching and Shearing—The same general instructions given for forming are applicable to blanking, punching or shearing; *i.e.,* sheet thicker than 0.020 in. should be heated to temperatures which increase with thickness. In fact, it is good practice to keep the dies warm with a common heat lamp or infra-red lamp. Dies should be kept sharp to avoid laminations and cracking of the molybdenum sheet.

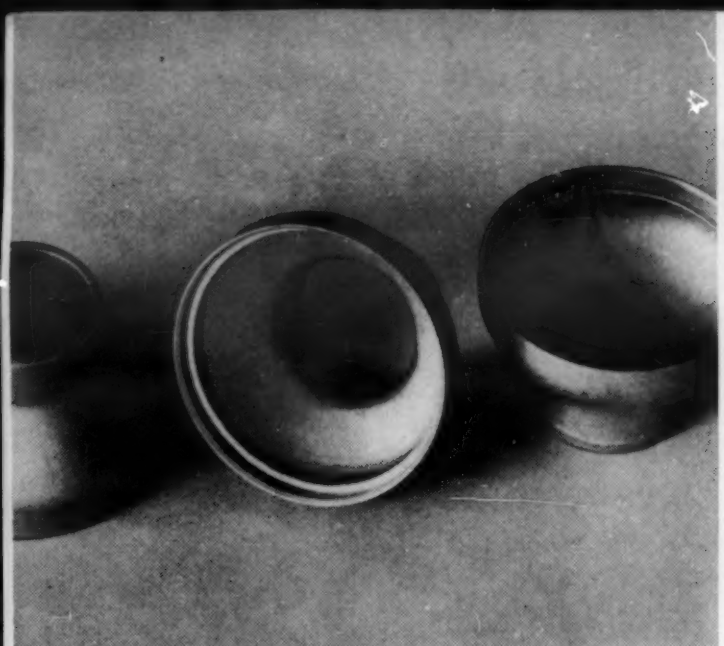
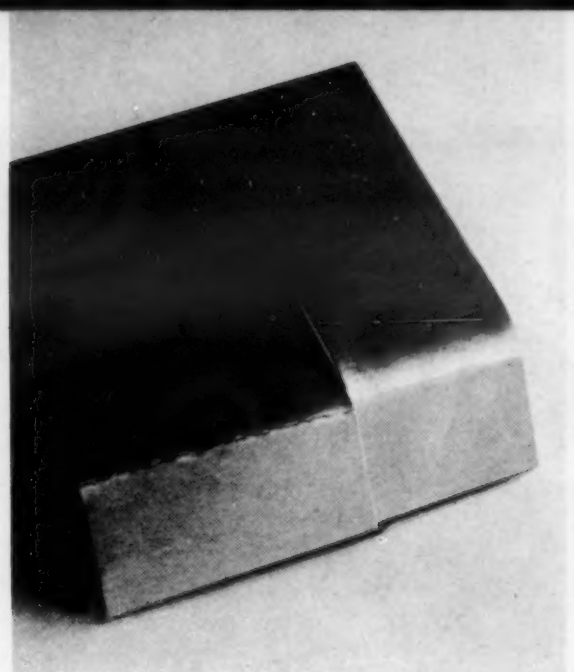
Sheet of 0.050 in. and thicker should not be sheared to finish dimensions, but should be sheared to within 1/16 to 1/8 in. of desired dimensions, then edge machined.

Because molybdenum is a valuable metal, fabricating procedures should be planned so that a minimum of scrap results. Molybdenum producers can assist users in designs of tools and dies and planning of methods for most effective and economical results.

Drawing and Spinning—Wherever possible, molybdenum parts should be designed for finishing in one drawing operation, and the diameter of the cup after the first draw should be not less than 60% of the diameter of the original blank. The possibility of cracking increases considerably with each additional draw and, because of this, parts should be designed for a minimum number of draws.

Dies should be made of aluminum bronze or other material with a low coefficient of friction. If steel dies are used, they should be well lubricated with light oil. Low melting alloys can be used for experimental work or short runs. Rubber or pneumatic die cushions should be used where required.

Molybdenum can be spun by conventional techniques, using aluminum bronze tools, or other tools having a low coefficient of friction. Sheet less than 0.020 in. thick can usually be drawn or spun at room temperature,


***Left:** Molybdenum cones were deep-drawn from 0.062-in. sheet, the inside of the large diameter being machined to fit. Center: Part of this sheet cracked when bending was tried with sheet in chilled condition, though it bent easily when warmed slightly. Right: Support for molybdenum furnace liner was spun from 0.030-in. sheet. Sharp angle at the bottom would have been difficult if part had been drawn.*

although it is better practice to heat the sheet and the dies to 200 to 325 F. Heavier sheet must be heated for drawing, the temperature depending upon the thickness of the sheet and the amount of draw. It would be extremely difficult to list recommended temperatures for all conditions, so that it is probably best to determine these temperatures experimentally.

Molybdenum sheet can be heated to temperatures up to approximately 750 F on a gas or electric hot plate without too much danger of oxidation, although thin sheet should not be exposed to air at this temperature for too long a time. When higher temperatures are required, the sheet should be heated in electric furnaces in an atmosphere of hydrogen or dissociated ammonia. It should be removed from this protective atmosphere for as short a time as possible for working and, if further working is necessary, it should be returned to the furnace immediately.

For drawing, spinning or severe forming operations, cross-rolled annealed sheet should always be specified. Such sheet has been properly worked to impart the necessary ductility for forming in any direction.

Annealing—Stresses induced by forming or drawing can be relieved, as with other metals, by annealing. The recommended annealing temperature is 1830 F, and the metal should be held at this temperature *not more than 3 min.* This time should not be exceeded, nor should the temperature be exceeded. Otherwise recrystallization and embrittlement will occur, regardless of the type of heating, or the type of atmosphere or lack of atmosphere. Molybdenum can be annealed at a lower temperature, which, of course, requires a longer time at heat, the time being dependent upon the temperature. The lowest recommended temperature is 1355 F.

Machining

There has been some mention in the literature of "free machining" molybdenum. To use this term in comparison with free machining brass or free machining steel is decidedly a misnomer.

The only property of pure molybdenum which has any influence on its machinability is its grain structure. A molybdenum bar as sintered, *i.e.,* with no working, has been found to be slightly more easily machinable than metal which has been worked. The proper structure of worked molybdenum for best machining properties is a uniform fine fibrous grain. The following information on machining applies to properly wrought molybdenum.

The machining characteristics of molybdenum cannot be compared easily to those of other metals. Perhaps the nearest comparison that could be made is SAE 1040 or 1045 steel which has been heat treated to a hardness of 30 Rockwell C. Such a material would have machining characteristics generally similar—but only generally similar—to those of molybdenum.

Molybdenum machines with the crumbling chip, which is characteristic of hardened SAE 1040 steel. Although it is possible to machine molybdenum with high-speed steel tools, tungsten carbide tools are recommended. Satisfactory results are obtained with Grade 2A5 Vascoloy-Ramet tools.

Turning and Milling—For inside and outside turning, tools should be ground to angles and rakes similar to those used for cast iron. Correct tool shapes are illustrated in "Machinery's Handbook" and in the literature of carbide tool manufacturers. Speeds up to 100 ft. per min., with a depth of cut up to ⅛ in., are satisfactory for rough turning. The feed should be 0.015 in. For finishing work, speeds up to 100 ft. per min., with a depth of cut of 0.005 in. to 0.015 in., and a feed of 0.005 in. to 0.010 in., should be used. It is important in turning that the depth of cut always be greater than 0.005 in. If the depth of cut is less, tool wear will be excessive.

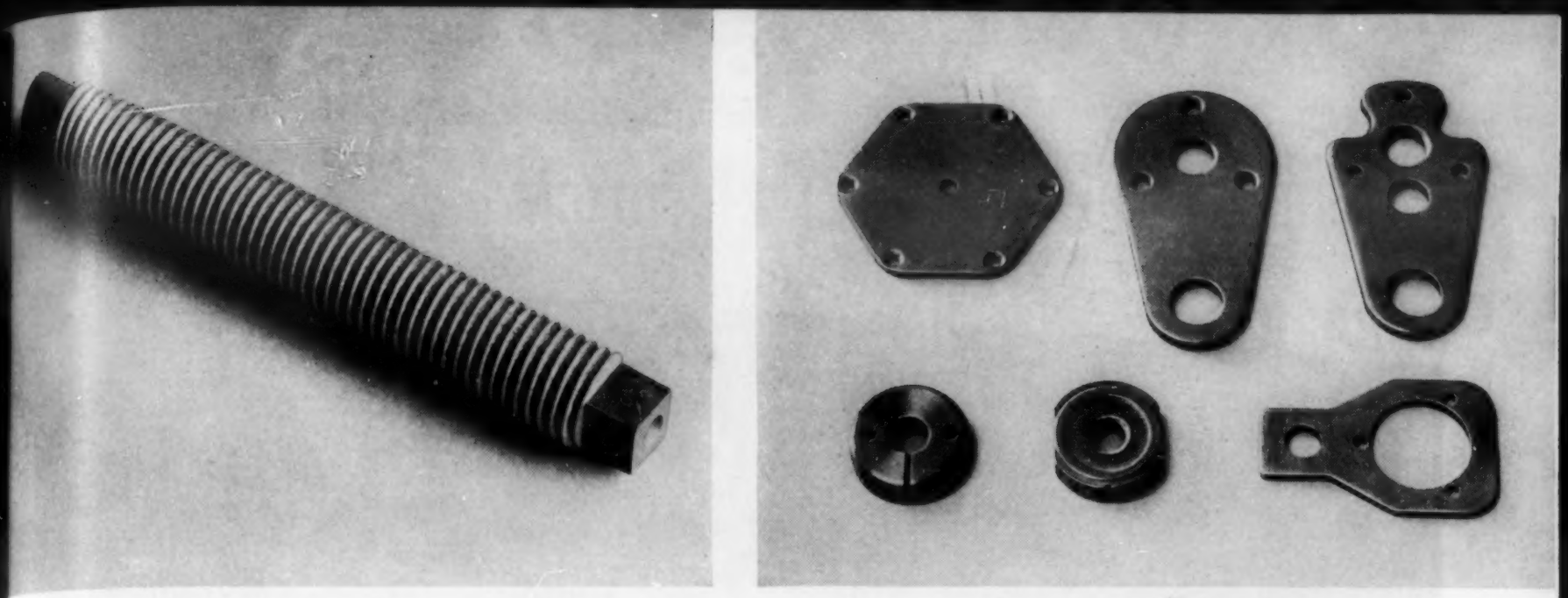
Sulfur-base cutting oil should be used as a lubricant for roughing cuts, and kerosene or sulfur-base cutting oil should be used for finishing work. If lubricants are not used, tool wear will be excessive.

Molybdenum has a tendency to chip while being machined, and care must be taken to prevent this. Work should be firmly chucked, tools rigidly supported, and machines should be sufficiently powerful and free from chatter or backlash.

Face milling is not generally recommended. It can be done when necessary, however, by the use of carbide-tipped cutters. The speeds and depth of cut should be similar to those used in lathe turning, except that the depth of cut should not exceed 0.050 in.

Molybdenum plates can be edge machined. In fact, plates thicker than 0.050 in. should be edge machined rather than sheared to finished dimensions. This work can be done either on a shaper or milling machine, and the machining should be done along the edge, rather than across the edge. The molybdenum should be clasped between steel plates while being machined to avoid chipping the edges.

Drilling, Threading and Tapping—Molybdenum can be drilled with



Left: Molybdenum clamping screw for furnace electrode was machined from 0.725-in. rod. Thread was cut with single point tool (no sharp point on end) on engine lathe, and square end was milled. Right: These parts were hot blanked from heavy sheet. Larger holes are punched, smaller ones drilled or drilled and countersunk. Two pieces at lower left are made entirely by machining.

high-speed steel drills, although carbide drills are recommended for deep drilling. When using high-speed steel drills, the speed should be 30 to 35 ft. per min. with a feed of 0.003 in. A sulfur-base cutting oil should be used for all drilling, tapping or threading.

Some difficulty may be experienced in threading or tapping. The thread depth should not be more than 50 to 60% because of the tendency of molybdenum to chip. Rethreading or tapping should not be attempted at any time.

Molybdenum can be roll threaded. In this operation, the molybdenum stock and the die should be heated to approximately 325 F. It is neither necessary nor desirable to heat molybdenum beyond this temperature, since it attains ample workability at that point. Molybdenum can be heated to this temperature in air without danger of oxidation.

Grinding—In grinding, molybdenum behaves in a manner comparable to cast iron. Aluminum-oxide, silica-bonded wheels have proved satisfactory for most purposes. A 60-grit wheel, such as Norton No. 3860, is suitable for most grinding. When a fine finish is desired, a finer grit wheel can be used, but wheels of a grit finer than 80 tend to load rapidly and require frequent dressing.

Wheel speeds for either cylindrical or surface grinding should be about 6500 ft. per min. For cylindrical grinding, the work speed should be 250 to 300 ft. per min., and the depth of grind not more than 0.0002 in.

For best results, molybdenum should always be ground with plenty of coolant.

Joining

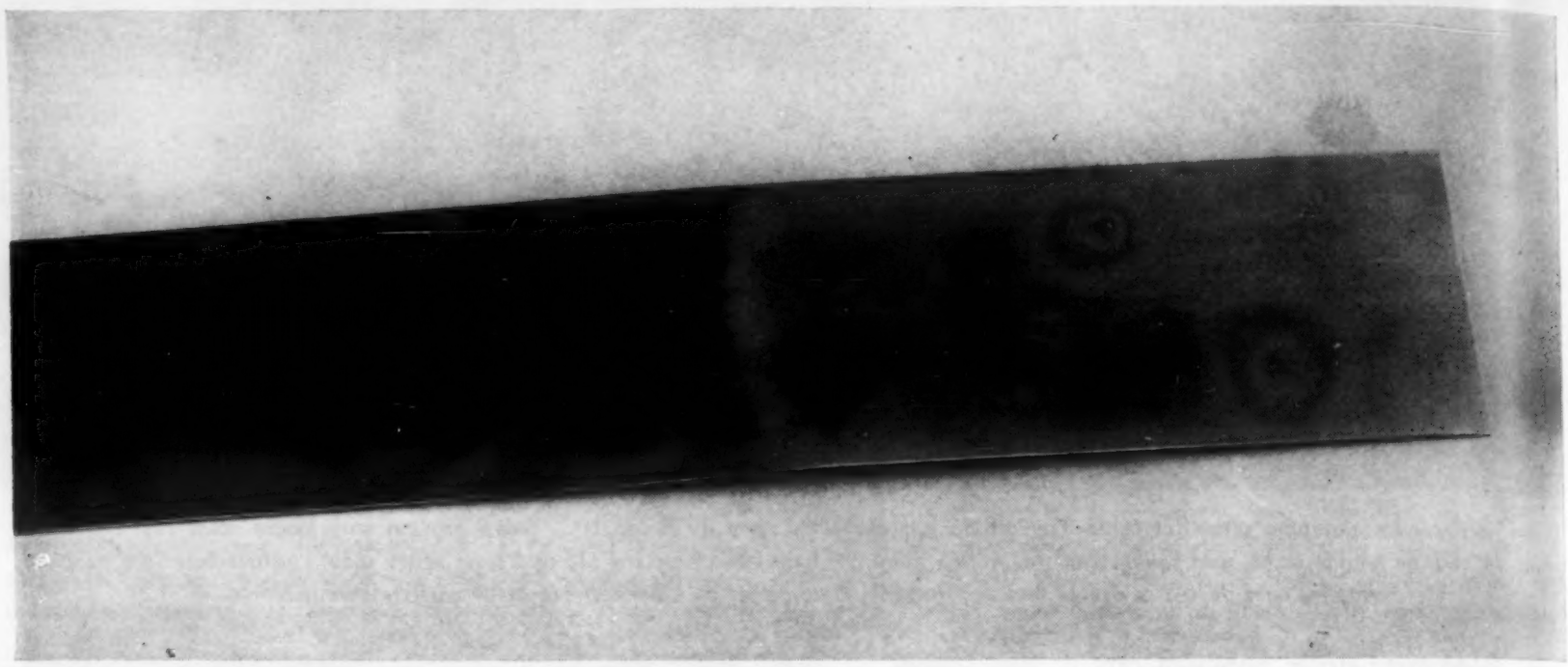
Molybdenum parts are commonly joined by riveting (headed molybdenum rivets are available) or brazing, and sometimes by welding.

Anodes for electronic tubes (made from 0.006-in. sheet) are seam brazed under water with tantalum foil. Reinforcing ribs are rolled in after brazing and cap is fastened with spot welds.

Brazing—Brazing operations for relatively thin sheet can be done in a spot or seam welder, using copper or silver solder as the brazing medium. If all parts are well cleaned, no flux is necessary. Copper alloy electrodes can be used in the welding machine, but tungsten-faced electrodes are better.

For electronic tube parts, or other applications where temperatures beyond the melting points of copper or silver solder are encountered, tantalum foil of approximately 0.001-in. thickness is an excellent brazing medium. Brazing should be done under water to prevent oxidation of the tantalum foil.

Heavier sections of molybdenum can be brazed in hydrogen atmosphere furnaces without the use of a flux. Experimental copper or silver solder brazes can be made with a torch, but a flux must be used, and the results are largely dependent upon the experience and skill of the operator.



Molybdenum parts for electronic tubes are usually blasted with steel grit to provide greater radiation surface. Blasting nozzle is kept at an angle nearly tangential to the work to produce fine "whiskers" rather than mere indentations.

Welding—Molybdenum can be resistance welded. The preferred method is to stamp or roll a series of serrations or dimples in one of the sheets to be joined, thus providing a number of projections at which welding will be localized. The resultant weld structure is somewhat brittle.

Spot welds of fairly satisfactory quality can be made if the surfaces of both sheets to be joined are etched. Any molybdenum sheet to be brazed or welded should be thoroughly cleaned of grease and oxide immediately before joining.

Only welding equipment with precise controls should be used, as excess heating will result in extremely brittle welds. Current values and timing are best determined by experiment. Electrodes should be kept clean and well-dressed.

Surface Finishing

Ordinary cleaning and degreasing of parts made from molybdenum sheet present no special problems, and conventional methods and materials can be used.

Chemical Cleaning — Electronic tube parts, which must be chemically cleaned, require somewhat more careful treatment. The hot chromic acid cleaning solution commonly used for cleaning glass is recommended. A saturated solution of potassium dichromate in hot concentrated sulfuric acid can be used, but chromium trioxide is preferred to potassium dichromate because its use eliminates the possibility of potassium residues in crevices of fabricated parts. This cleaning solution should be used at 194 F, and should be kept red at all times. When the liquid becomes muddy or turns green, it should be discarded.

After the chromic acid wash, the parts should be thoroughly rinsed, preferably with hot distilled water. If running distilled water is not available, three dip washes will suffice, but it is important that all cleaning solution be removed. Electropolishing for bright finish can also be done in a chromic acid solution.

Etching and Polishing — Etching, in preparation for resistance welding or brazing with tantalum foil, is accomplished by immersing the molybdenum sheet for 10 sec. at 194 F in the following solution:

Sulfuric acid concen. .... 5 gal.
Chromic acid ..... 375 g.
Hydrofluoric acid ..... 1 qt.
Nitric acid concen. ... 1/10 qt.

The sheet should then be immersed in the chromic acid cleaning solution previously described until the blue oxide disappears.

For metallography, molybdenum can be polished with emery to No. 000 levigated alumina, and then etched with alkaline potassium ferricyanide. Etching and polishing should be repeated until grain boundaries appear.

Grit Blasting—Molybdenum parts for electronic tubes are often blasted with steel grit to provide greater radiation surface. The recommended procedure is a blast of a few seconds with No. 90 steel grit at a pressure of 20 to 40 psi., followed by thorough cleaning in hydrochloric acid to remove iron particles. Sand, alumina, silicon carbide or other abrasives should not be used because they become embedded in the molybdenum and cannot be removed with any chemical treatment which would not damage the metal.

Since the purpose of grit blasting is to increase the amount of surface per unit of area, the blasting should be done in the manner which will produce fine "whiskers" rather than mere indentations on the surface. Sharp particles of grit will do this, while dull ones merely indent the surface. To achieve best results, the blasting nozzle should be held at an angle nearly tangential to the work, rather than perpendicular to the work.

Molybdenum parts for electronic tubes are often "hydrogen-fired" before assembly into the tube. The purpose of this operation is to reduce oxides and make a chemically clean component. The operation also relieves cold strains and set dimensions. The temperature range for hydrogen firing is usually 1470 to 1830 F, and the time is 10 to 30 min. Pure, dry hydrogen gas is recommended. Dissociated ammonia can be used if no further forming is to be done, but precautions must be taken to see that no free ammonia is present in the atmosphere. Fired parts, of course, must be cooled in the same protective atmosphere. Small parts are often loaded into trays or boats made of molybdenum sheet. These are easily made by the user or can be ordered from a supplier.

Materials Problems in Production Solved with Microscope

An interesting group of case histories shows that the microscope is an invaluable trouble-shooting tool which can quickly and cheaply help find the answer to many material difficulties.

by R. WACHTELL, American Electro Metal Corp.

• THE MICROSCOPE IS NOT only a research tool. It is also an important production aid.

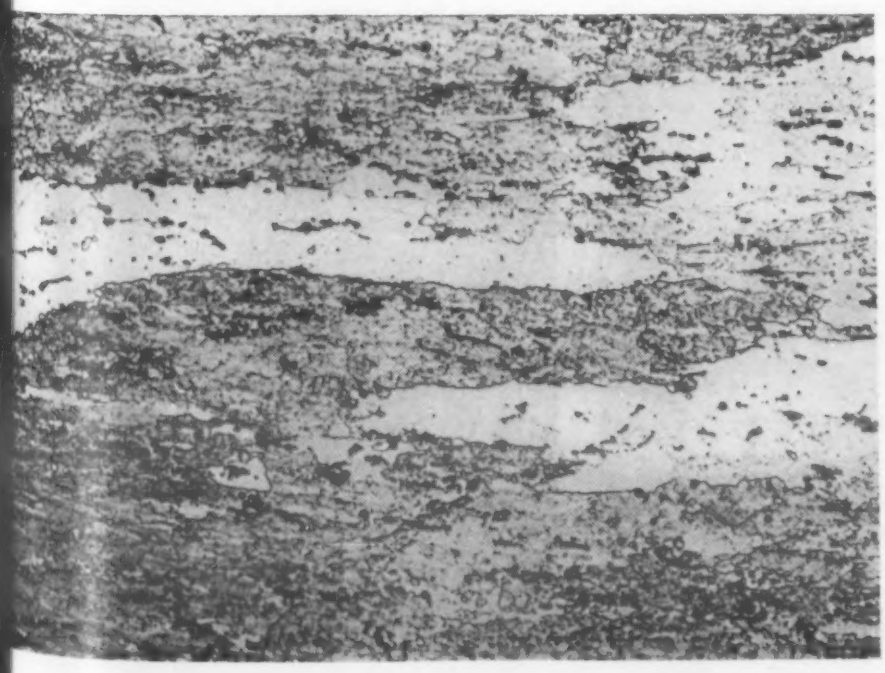
There is probably no position more interesting than that of the engineer or metallurgist who is called upon to explain why materials, parts or processes that worked yesterday do not work today. In such a job the microscope is an indispensable instrument which tells quickly, easily and cheaply whether hunches are right or wrong. It also gives suggestions where intuition fails. Seldom indeed does the careful observer leave the instrument without knowing a great deal more about the material under consideration than when he first sat down.

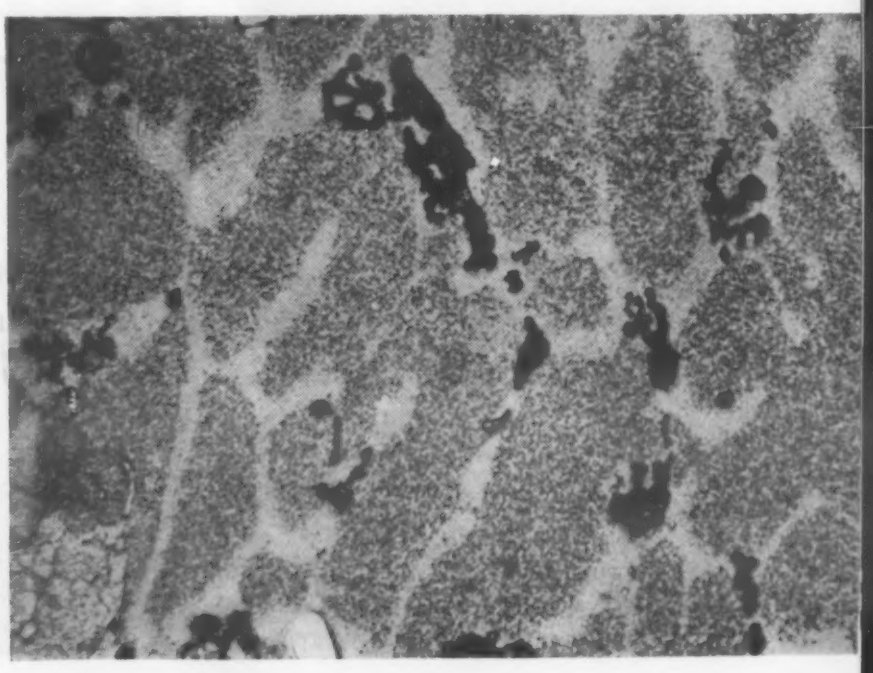
The following cases of "in plant" troubles—failures of materials, parts or processes to work as they should—are drawn from experience. In some cases, trouble was caught before it occurred. In other cases, the microscope provided the immediate explanation for the trouble and, once this was understood, the difficulty was easily remedied.

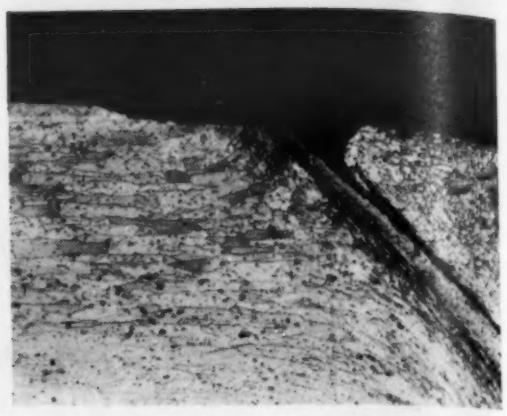
Incomplete Forging—The material illustrated below was specified as a high strength aluminum alloy forging to be used in a critical airplane landing gear part. Since the airplane was an experimental model, and it was uneconomical to make forging dies to strike out the few parts required, a few large forged billets were obtained and the parts "hogged out." When the nearly finished parts cracked open spontaneously during machining, the project engineer became alarmed and called for help.

The microscope quickly supplied the answer. The photomicrographs below give a comparison of the structure developed near the surface of the billet and that of its center. The practically undisturbed grain structure, residual coring and lack of breakdown of eutectic in the right photograph all show what little effect forging had produced in the center of this large billet. Physical properties of this material would naturally be inferior to those of properly forged metal—sufficiently inferior to warrant suspicion of failure in service, especially in aircraft design where weight requirements necessarily reduce safety factors.

Spontaneous failure in the billet was unquestionably the result of internal stresses, probably induced by the non-uniform forging operation. Because this fault was inherent in large billets, it was recommended that design of the part be altered to permit bolted segments of smaller forged stock in the experimental part. This was done and the craft was built and flown without incident, at least so far as this part was concerned.



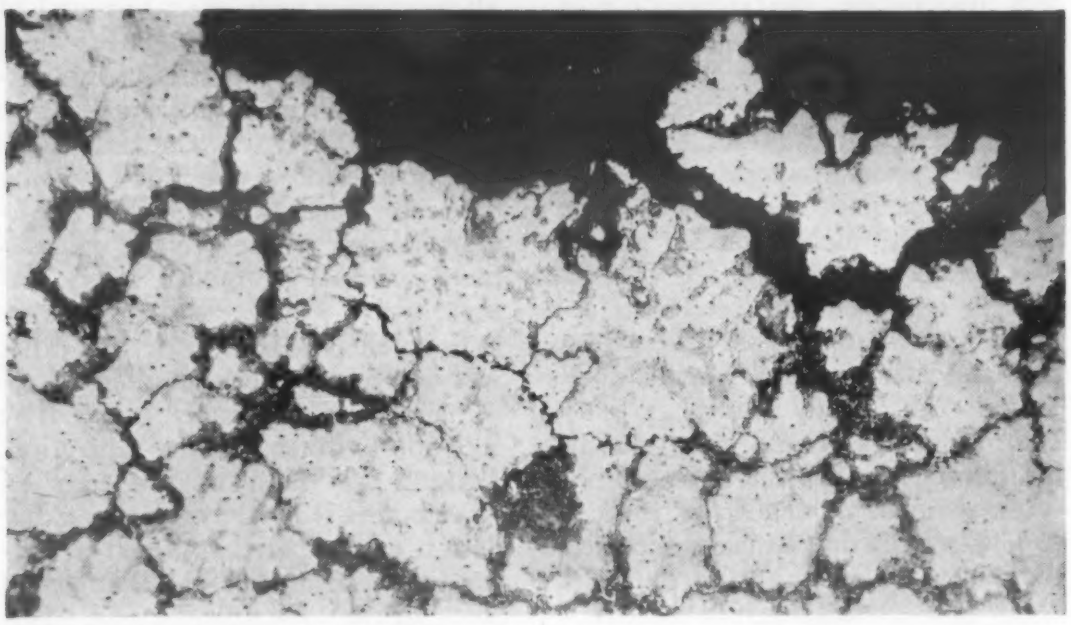




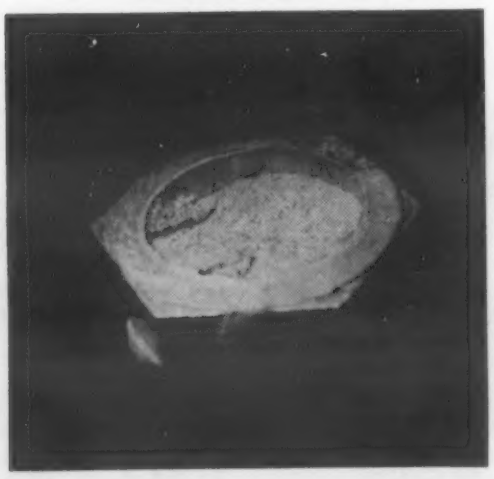
Dimpling Troubles—New high strength aluminum alloys, during the first months of their use, brought fresh problems to fabricating plants. Flush-rivetted skins of such material proved difficult to "dimple," *i.e.*, punch in the recessed hole which receives the rivet used as a fastener. Methods engineers devoted considerable time and effort to establishing a sound dimpling method. When they thought they had one, they brought their product to the laboratory for a check. It was a good thing they did so. Left shows what had happened inside the sheet; the ductile cladding (nearly pure aluminum) concealed virtually complete internal shear. The methods men returned to their studies.

They were back again in a few weeks to demonstrate that the problem was solved. In a sense it had been; the dangerous internal shear was entirely absent. Right shows, however, that their method was still unsound because the corrosion resistant cladding had been stripped away from the area surrounding the rivet head.

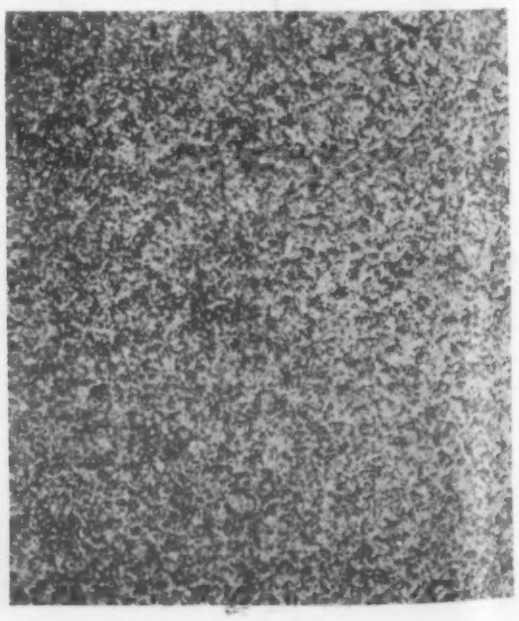
A metallurgist can sometimes make enemies this way. It is more pleasant to blame a supplier for your troubles, if you can, and avoid hurt feelings around the plant. This usually happens often enough to please the most vindictive types. In the next four cases, the hot coals were heaped on the heads of careless suppliers or subcontractors.



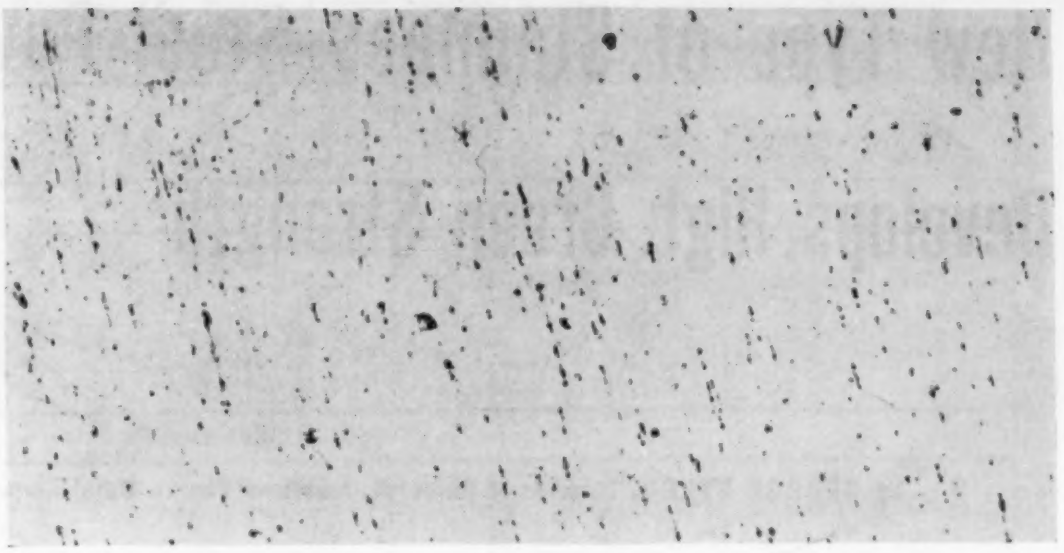
Poor Casting Technique—Complete service failure of a critical magnesium alloy casting was caused by the micro-shrinkage cracks and porosity shown here. This discovery resulted in a change in casting technique and also in the X-ray technique which, until then, had been used to inspect the parts.

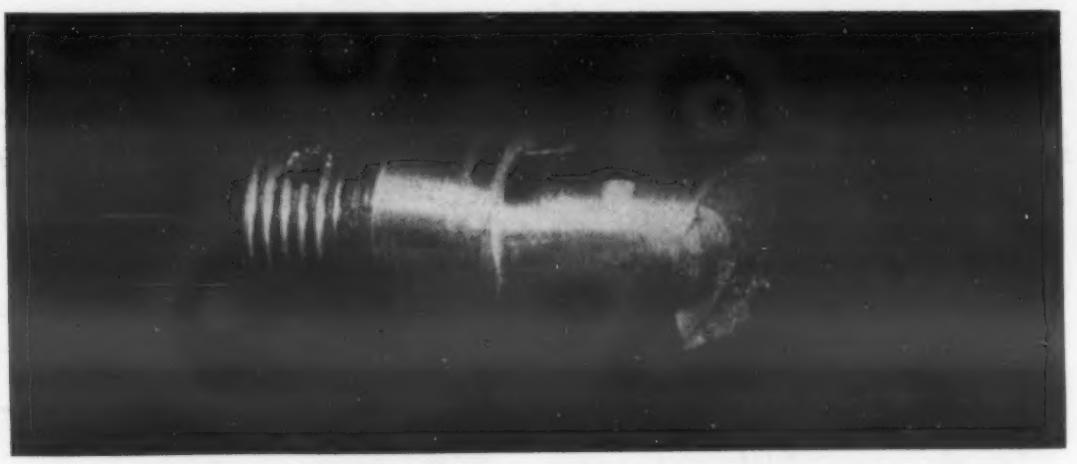


Unsound Material—The sheared bolt head, illustrated at left, involved many telephone calls and much material tracing to pull unsound parts from stock. Such a condition can wreak havoc in a plant if not soon corrected. The comparison of the structure of the sheared bolt head, center, with that of a sound bolt head, right, made it clear that failure could be attributed to large grain size and numerous inclusions in the bolt material.



Forming Failures—In this case, sheet steel bought for forming into shapes had to be returned to the supplier. As shown here, it was dirty steel. But the shop man was puzzled over why he could make good pieces one time and bad pieces another time, when he used the same sheet, same forming dies, "same everything." And everything was the same except that some of the pieces were blanked out with the inclusions running *across* the bending axis, and some with the inclusions *along* the bending axis. In the latter instance, failure was immediate and unmistakable.





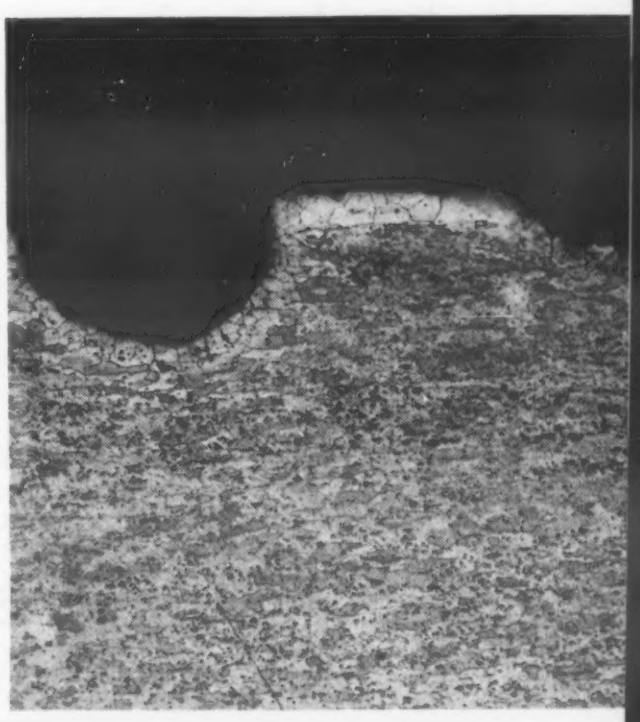
Annealed Bolts—Another clear case of a vendor's carelessness, compounded in this instance by slack inspection procedure, is shown here. The bolt shown had failed in service and had been returned from the field for study. The blueprint specification called for heat treated alloy steel bolts, hard chromium plated. As the photomicrograph demonstrates, the plater had done an excellent job, but the heat treater had not been given a chance. Many of these fully annealed bolts found their way into service and were replaced in the field as failure occurred.

Aluminum Pitting—Opportunities to play detective are numerous, but occasionally a particularly interesting case arises in which the metallurgist, with a single glance at the specimen on his microscope, is able to work seeming miracles.

A good example was provided as the result of an epidemic of pitting on aluminum sheet in a heat treating department. The offending sheet had been solution heat treated in molten nitrate salt baths, as had been the custom, but suddenly the department found itself unable to turn out clean work. Analysis of the bath and a check of the pyrometers showed everything to be in order.

After looking briefly in the microscope, however, the metallurgist was able to advise that the degreasers be cleaned out and checked; and his diagnosis was proved correct. Grease and organic material remaining after poor cleaning caught fire upon immersion of the sheet in the fused nitrate salts. Although the flames could not be seen, the results of the burning and eutectic melting which lined the pits were unmistakable under the microscope.

It has been suggested here that the use of a microscope and a cultivated eye will go a long way in the solution of plant production problems. Some elementary problems and solutions have been presented. As the eye becomes better and better trained to notice what it sees, more and more information will be wrung from photomicrographs and more subtle problems unraveled.



New Type of Stainless Steel Powder Develops High Green Strength

by GEORGE STERN, Director of Research, American Electro Metal Corp.

Out of the continuing search for alloy steel powders that can be readily molded and that have adequate green and sintered strengths has come a promising new group of stainless powders.

• GROWTH IN POWDER METALLURGY, as measured in terms of tonnage consumed, has been rapid in the field of iron and copper-base parts. That an equally rapid pace has not been set in the field of stainless steel parts can be attributed to several obstacles that beset the powder metal parts producer when he tackles this alloy powder field. These are:

(1) Poor moldability of available stainless steel powders.
(2) High purity, low dewpoint atmospheres required in sintering.
(3) High sintering temperature, about 2372 F, required to obtain reasonably good physical properties.

This article describes two grades of stainless powder made by a new method. One is essentially a 14% chromium, balance iron, referred to as Grade 140; and the other a 17 to 18 chromium, 8 to 9% nickel composition, referred to as Grade 188. While it is not claimed that these powders can be sintered at lower temperatures, nor that they do not require high purity, low dewpoint atmospheres, it can definitely be stated that these powders have good green strength and moldability. In addition, by sintering in gettered boats, some of the objections to low dewpoint, high purity atmospheres can be overcome.

While these powders are still in the development stage, it is felt that they will permit production molding of complicated parts having good green strength and adequate sintered strength.

Table I—Characteristics of Two Grades of Stainless Powder

Property	Grade 140	Grade 188
Apparent Density	2.56 g./cc.	2.28 g./cc.
Flow	30.3 sec./50 g.	34.4 sec./50 g.
Screen Analysis		
— +100	8.5%	1.0%
-100 +150	35.5	35.5
-150 +200	28.0	27.0
-200 +250	10.0	9.0
-250 +325	9.9	9.5
-325 —	9.0	18.0
Chemical Analysis		
Cr	14.5%	17.9%
Ni	—	8.6
C	0.02	0.04

Table II—Transverse Rupture Strengths of Green Bars of Various Stainless Powders

Compacting Pressure	Transverse Rupture Strength, Psi. (Average of 2 Bars)			
	Grade 140	Grade 188	Commercial #1	Commercial #2
25 Tsi.	1708	841	73	299
35 Tsi.	2855	2013	157	580
45 Tsi.	4580	3030	350	859

Properties of the Stainless Powders

The characteristics of both types of powders as prepared by this method are summarized in Table I. The low carbon contents of these powders is believed to be a particular advantage where corrosion resistance is a major consideration. The screen analysis can, of course, be varied to provide more −325 mesh material, if desired.

Figure 1 shows characteristic particles of Grade 140. The equi-axed sponge-like particles shown are a particular advantage of this type of powder since powders exhibiting this type of structure are generally easy to mold and have good green strength.

Green Strength—In order to evaluate green strength, bars measuring 1⅛ by 7/16 in. were pressed in a die using no lubricant and broken in a transverse rupture test. For comparison purposes, two commercial grades of stainless powder of approximately 18 chromium, 8% nickel composition, and also all −100 mesh screen size, were evaluated for transverse rupture strength. The results obtained on green bars of these four types of stainless powder, pressed at 25, 35 and 45 tsi., are summarized in Table II.

The transverse rupture strength of green bars is far superior for grades 140 and 188 when compared with other commercial grades of stainless steel powders. Comparing Grade 188 with the commercial grades of similar composition, its green strength as

Table III—Properties of Stainless Powders As-Pressed and Sintered, and As-Pressed, Sintered, Repressed and Resintered

Press, Tsi.	Sinter Shrink, %	Sinter Dens., G./Cc.	Repress, Tsi.	Resinter Shrink, %	Resinter Dens., G./Cc.	Rock. Hard. F	Yld. Pt., Psi.	Ult. Tens., Psi.	Elong. in 1 In., %	Red. Area, %
Grade 140[1]										
25	8.2	5.99	—	—	—	37.5	21,600	26,450	8.5	4.1
25	—	—	35	1.7	6.70	71.5[2]	26,900	45,000	20.5	19.0
35	6.5	6.36	—	—	—	57	21,900	30,250	7.8	4.3
35	—	—	40	1.0	6.92	80.5[2]	31,900	48,650	18.5	15.8
45	4.6	6.64	—	—	—	63	25,500	39,950	13.5	8.7
45	—	—	45	1.1	7.00	83.5[2]	32,700	49,100	22.0	19.8
Grade 188[3]										
25	4.4	5.20	—	—	—	47.5H	10,300	14,325	5.0	2.5
25	—	—	35	0.3	6.01	83	19,075	27,250	6.8	4.0
35	5.3	5.57	—	—	—	68.5	15,930	19,875	6.0	2.0
35	—	—	40	1.0	6.32	90	19,975	31,800	11.8	5.6
45	6.0	5.88	—	—	—	74	16,360	24,990	8.0	3.8
45	—	—	45	0.2	6.45	94	21,450	36,150	12.3	5.7

[1] *Theoretical density = 7.75 g./cc.*
[2] *Measured on B scale and converted to F reading.*
[3] *Theoretical density = 7.93 g./cc.*

measured by transverse rupture is seen to be about three times as great as the best commercial grade.

Properties of Pressed and Sintered Compacts—To evaluate pressed and sintered compacts of these stainless powders, bars measuring 3 by ½ by ½ in. were pressed using double action pressing at 25, 35 and 45 tsi. and sintered at 2372 F for 1 hr. using hydrogen. Because the dewpoint of the hydrogen inside the furnace was poor, it was therefore necessary to use a gettering technique, whereby the actual work was enclosed in an Inconel box formed by placing a rectangular covering box inside of a slightly larger supporting box. The space in between the cover and supporting box was filled with a 50-50 mixture of 100 mesh alundum and 25-75 ferrochrome (25 Fe, 75% Cr). All hydrogen coming in contact with the bars had to first pass through this seal of alundum and ferrochrome, and this mixture thus "gettered" or removed oxygen and water vapor, providing a very dry pure hydrogen inside the box and in contact with the work.

A duplicate set of sintered bars were re-pressed at 35, 40 and 45 tsi., respectively, and resintered for an additional hour at 2372 F.

The pertinent test results obtained from standard tensile bars (1-in. gage length, 0.250-in. dia.) are summarized in Table III and Figs. 2 and 3. The results show that:

(1) Grade 140 develops higher densities and superior physical properties than Grade 188 for equivalent pressing and sintering treatments.

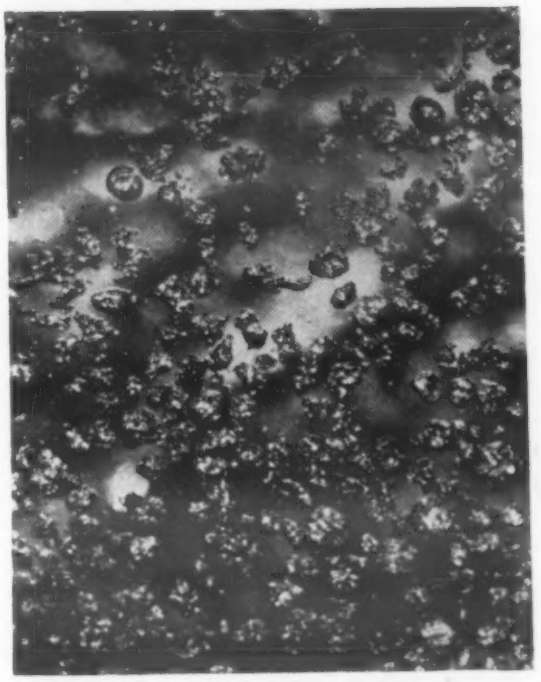


Fig. 1—Equi-axed sponge-like particles as shown here, are characteristic of the new stainless steel powders. (30X)

(2) A commercially feasible cycle consisting of pressing at 35 tsi. followed by sintering 1 hr. at 2372 F develops an ultimate tensile strength in the case of Grade 140 of 30,250 psi. and an elongation of 7.8%. For Grade 188, treated similarly, these properties become 19,875 psi. ultimate tensile strength and 6.0% elongation.

(3) Where repressing and resintering are applied, the physical properties are appreciably improved. Thus, for the same bars pressed at 35 tsi. and sintered 1 hr. at 2372 F, repressing at 40 tsi. followed by resintering for 1 hr. at 2372 F results in increas-

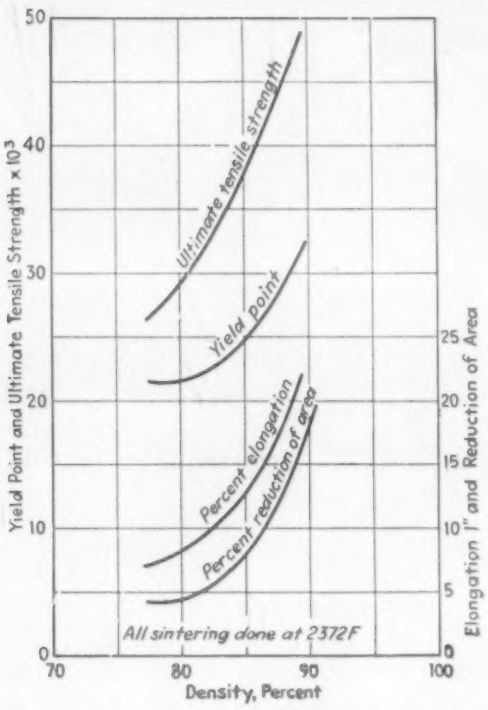


Fig. 2—Variation of mechanical properties with density for Grade 140.

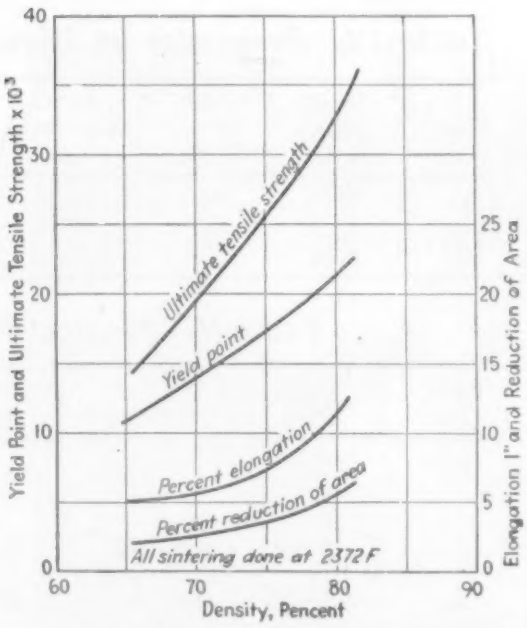


Fig. 3—Variation of mechanical properties with density for Grade 188.

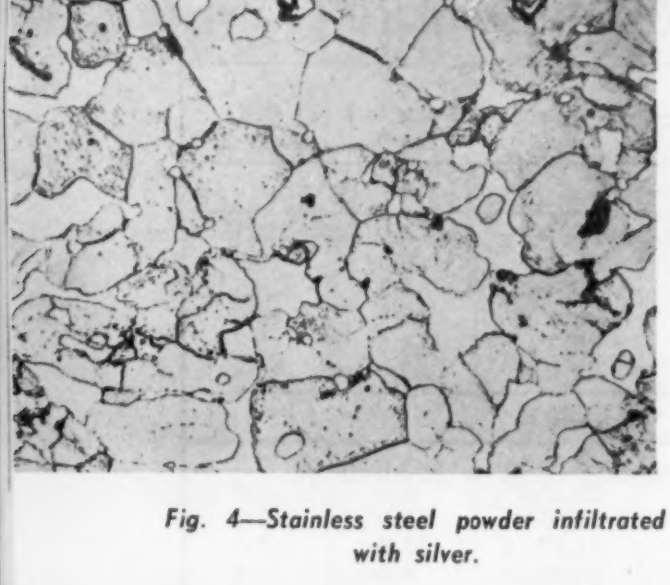


Fig. 4—Stainless steel powder infiltrated with silver.

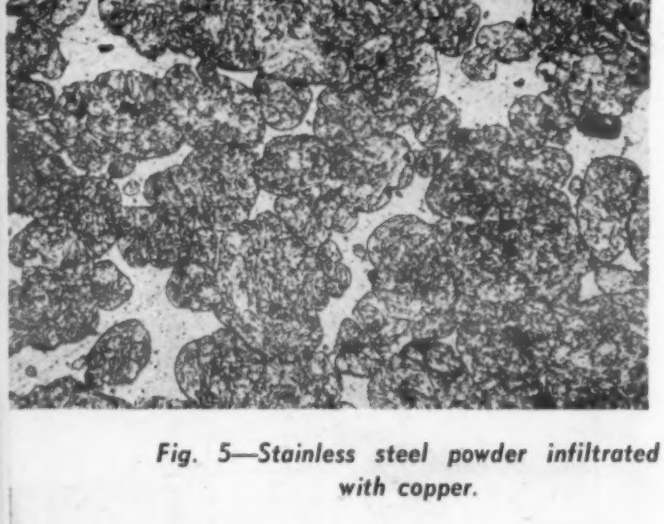


Fig. 5—Stainless steel powder infiltrated with copper.

ing the ultimate to 48,650 psi. and the elongation to 15.8% for Grade 140, and these properties to 31,800 psi. ultimate and 11.8% elongation for Grade 188.

These bars were also tested for salt spray resistance after sintering and found excellent in this regard. They were also found resistant to 30% HNO_3 cold or hot. Their corrosion resistance is comparable to type 430 steel for Grade 140, and type 302 steel for grade 188.

It should also be mentioned that while the Grade 188 powder is magnetic as prepared, it is nonmagnetic and completely austenitic after sintering 1 hr. at 2372 F.

Infiltrated Stainless Powder

These stainless steel powders can be infiltrated with silver or copper, and the resulting properties indicate possible use for special applications. Bars pressed at 25, 35 and 45 tsi. from Grade 140 stainless powder were infiltrated with pure fine silver at 2228 F for 1 hr. in dry hydrogen. The bars were infiltrated in the green condition, that is, without prior sintering. The properties obtained are summarized in Table IV.

The values indicate a material of good physical properties that can be made by infiltration in commercial furnaces and atmospheres. The salt spray resistance of this silver infiltrated Grade 140 material is excellent and the material should prove interesting for bearing and contact applications. Fig. 4 shows a photomicrograph of silver infiltrated Grade 140 stainless, and it is interesting to note that the silver shows no evidence of alloying with the stainless powder.

Grade 140 stainless powder was also infiltrated with copper, with and without presintering. Where presintering was performed it was carried out at 2372 F for 1 hr. in dry hydrogen and infiltration was carried out at 2192 F for 1½ hr., also using dry hydrogen. The physical properties obtained with copper infiltration on Grade 140 powder are summarized in Table V.

It can be seen that sintering prior to infiltration helps the elongation and reduction in area considerably for the case of copper infiltration. This is in consequence of the better bonds established between the stainless powder particles as a result of prior sintering. The salt spray resistance of this material is good, and the physicals obtained with only 25 tsi. compaction using presintering are 102,800 psi. ultimate and 5.5% elongation.

Fig. 5 shows a photomicrograph of a copper infiltrated Grade 140 material. The shape of the stainless particles is quite rounded, probably in consequence of the solubility between copper and the grade 140 material. This differs markedly from the case of silver infiltration, where solubility is negligible. This also explains the fairly low resistivity values in the case of silver infiltration, making the silver infiltrated material suitable for contact purposes.

References

"Determination of Green Strength by Transverse Rupture Test," J. P. Scanlan and R. P. Seelig, *Powder Metallurgy Bulletin*, Vol. 4, Sept. 1949, p. 128.

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This article is based on a paper presented at the Annual Meeting of the Metal Powder Association, Apr. 25-26, 1950.

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Table IV—Properties of Silver-Infiltrated Green Bars Pressed from Grade 140 Stainless Powder

Press, Tsi.	Green Dens., G./Cc.	Infil. Dens., G./Cc.	Resis. Microhm-Cm.	% IACS	Yld. Pt., Psi.	Ult. Tens., Psi.	% Elon., 1 In.	% Red. Area	Rock. Hard. F	Inf. Shrink, %	Salt Spray Resistance
25	5.47	7.59	17.9	9.6	22,800	37,000	9.3	10.5	63	4.42	Excellent
35	5.99	7.98	19.6	8.7	27,000	39,600	10.5	9.9	75.5	1.28	Excellent
45	6.28	7.92	22.4	7.6	34,450	47,000	11.5	12.2	83.5	0.79	Excellent

Table V—Physical Properties of Copper Alloy Infiltrated Grade 140 Stainless

Press, Tsi.	Green Dens.	Sinter	Sinter Dens.	Inf. Dens.	Yld. Pt., Psi.	Ult. Tens., Psi.	% Elon., 1 In.	Red. Area %	Rock. Hardness
25	5.56	—	—	7.85	78,400	78,400	1.0	0.81	B 99
35	6.01	—	—	7.90	98,200	102,000	3.0	1.21	B 102
45	6.17	—	—	7.80	98,350	99,700	1.8	1.61	B 103.5
25	5.66	2372 F 1 hr.	6.45	7.89	84,900	102,800	5.5	8.3	B 102
35	5.98	2372 F 1 hr.	6.68	7.95	87,700	105,250	6.3	8.3	B 100
45	6.24	2372 F 1 hr.	6.90	7.71	93,250	102,500	5.5	6.0	B 97.5

Speed and Uniformity in Joining Steel Provided by Contact Welding

This unique method of welding, in which the electrode touches the work at all times, can be used on mild and low alloy steels, and offers a number of advantages over conventional arc welding.

by T. C. DU MOND, Editor, Materials & Methods

• A FEW YEARS AGO there was introduced in Europe a method of metal welding which came to be known as contact arc welding. This method of welding is now being exploited in the United States by North American Philips Co., Inc. Where it is applicable, contact arc welding seems to offer a number of advantages over conventional arc welding.

The process derives its name from the fact that the electrode is kept in contact with the work at all times. Among other things, this method of welding eliminates the need of maintaining a specified length of arc. Success of contact arc welding is attained through extremely heavy coatings on the rods. The coatings contain steel powders, which serve two functions. Steel powders in the coatings prevent the heavy coatings from depositing undue amounts of slag in proportion to metal deposited. In addition, the steel powders provide sufficient electrical conductivity in the coating to establish an arc. It is not necessary to strike an arc, because of this "self-starting" action. Likewise, the action of the coatings is automatic in restarting after interruption in welding.

At present electrodes are available in three types. The C-18 is a deep penetration electrode of the A.W.S. E-6012-13 class, and the C-19 is a medium penetration electrode of the same A.W.S. class. The C-20 rod meets specifications for the A.W.S. E-6020 class electrode. Physical properties of the welds produced by contact electrodes equal or exceed those of standard A.W.S. electrodes of corresponding classes. All three types of rods can be used with a.c. or d.c. currents with standard equipment and accessories.

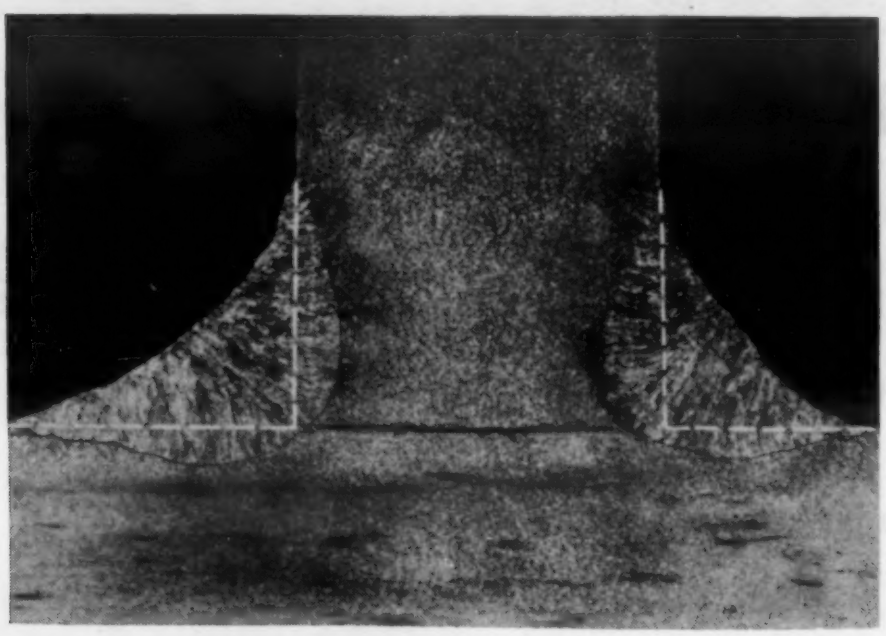
Although contact arc welding electrodes cost more than standard coated welding rod, the added cost is often overcome by the increased speed of welding. In other words, more feet of welding can be completed per hour. This has been borne out by both laboratory and production tests of several companies which have investigated contact arc welding. In addition to actually welding faster linearly, more metal can be deposited in one pass; therefore less passes are needed to complete a joint. The increase in speed over conventional welding is due to two factors. Higher currents are used with contact electrodes than would be used with standard electrodes of similar size, and higher arc voltages result from the cupping action of the contact electrode coatings. The following table shows recommended current ranges for electrodes of the C-20 class:

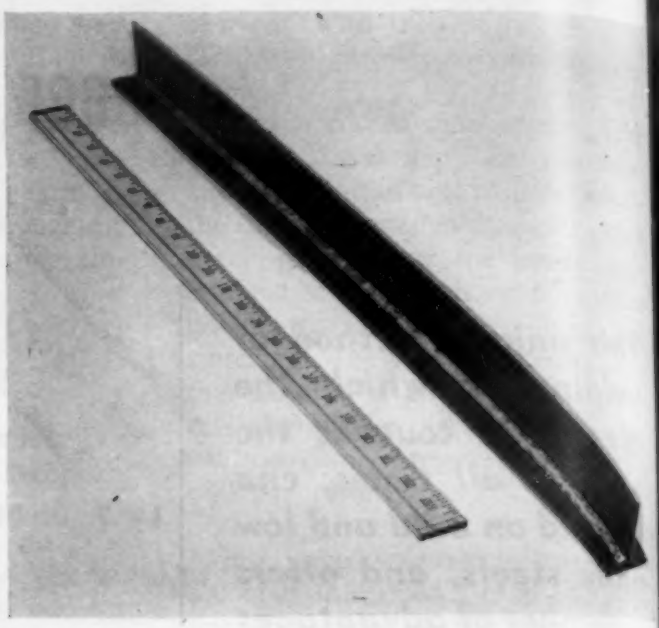
Diameter, In.	*Length, In.*	*Welding Current, Amp.*
5/32	18	200-250
3/16	18	275-350
1/4	18	350-500
5/16	18	450-600

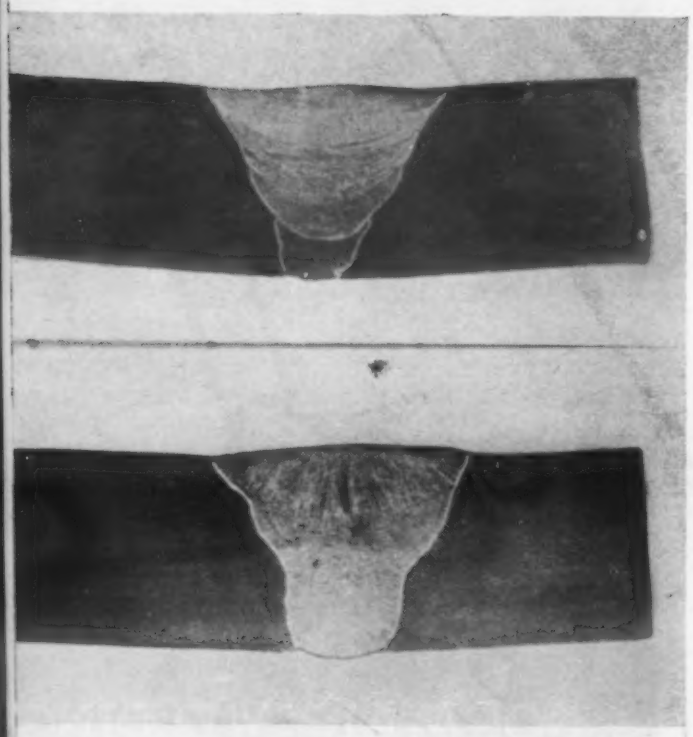
Arc action on the contact electrodes results in a deep cup being formed in the heavy coating. This deep cup provides a weld deposit that is of high quality, because the deep cup shields the molten metal momentarily and prevents the absorption of

Diagramatic sketches show essential differences in the arcs in contact and conventional methods of welding.

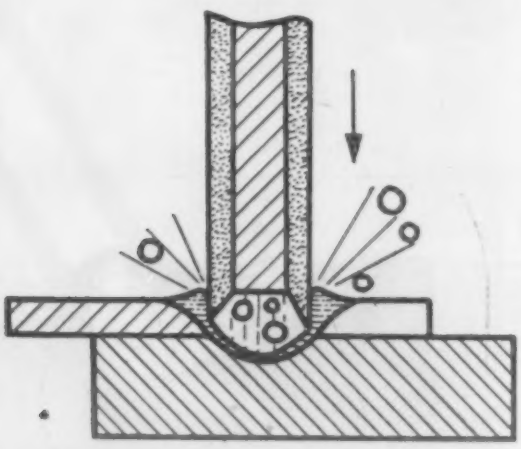
Fillet welds are readily made by contact welding. Left, cross-section of a fillet weld made in vertical down position; right, a 27-in. long fillet weld deposited with a 5/32-in. contact electrode.







Top, butt joint in ⅜-in. plate welded with ¼-in. E6020 electrode, using five layers. Bottom, same joint welded with ¼-in. contact 20 electrode, using only three layers. Time saving: 60%.



Contact welding electrodes can be used for spot welding. Sketch illustrates method and photograph shows two strips spot welded by this means.

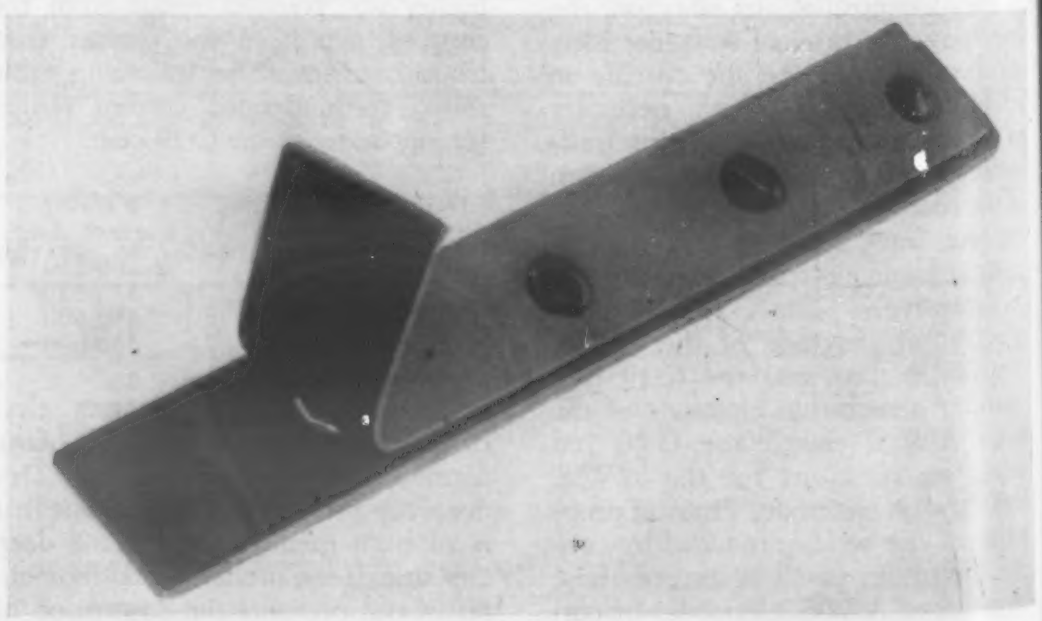
excessive nitrogen. This same deep cupping action is responsible for other advantages of contact arc welding. Not the least of these advantages is a considerable reduction of weld spatter over that resulting from standard arc welding.

Contact arc welding can be carried on in all positions and can be done without changing current for various positions. Because it is only necessary to maintain contact between the electrode and the work, welding with this type of rod can be done blindly as well as in restricted space. The ease of welding by the contact method often permits the use of less highly skilled labor because no specified arc length is necessary and weaving is not required. Uniformity of weld is easily maintained, because there is no variation in arc length to inject another control factor into the weld.

In the vertical down position, contact arc electrodes deposit welds of deep root penetration and sufficient throat thickness to provide joints of high strength and reliability. This type of welding is made possible by the cupping action of the electrode coating, plus the fact the extra metal is provided by the coating.

The fact that higher speeds are maintained is important where distortion might be a problem. For although there is a good penetration of weld metal into the base metal, the heat-affected zone is not so great. Another contributing factor is the fewer passes required to complete a weld. Distortion has been figured as roughly proportional to the number of passes required to fill a joint.

The electrode does not freeze to the work; therefore contact welding electrodes can be used for spot welding. Sheet from 1/32- to ⅛-in. thick has been joined in this manner. Likewise, a thin sheet can be joined to plate without difficulty. When two pieces are in contact, the electrode is placed perpendicularly on the top sheet. When the arc starts, the electrode is pushed lightly through the top sheet. The electrode tip comes in contact with the lower sheet or plate. As soon



as the interfaces are molten the electrode is withdrawn and the void filled.

One type of welding on which contact arc welding is proving highly satisfactory is the horizontal-vertical type. Usually on this class of welding there is a tendency for the weld bead to sag. Contact electrodes produce symmetrically shaped beads. The molten metal is supported by the deep cup in the electrode as well as through the concentrated blowing action of the arc.

Test Results

Several steel fabricators who normally use welding in their production have tried contact welding for the purpose of comparing this method with their present methods.

Here are some typical comparisons:

In boiler manufacture the job was that of welding the wrapper to the furnace at the mud ring. Established procedure involved the use of a standard ¼-in. E 6020 electrode with 300-amp. current. The welding required 22.6 min. Using a ¼-in. contact electrode (C-20) with 400-amp. current required only 12.0 min. to complete the weld. The saving represents a saving in standard minutes of 88%, or a direct labor saving of 47%.

In another job, involving an unbeveled groove weld in 5/16-in. plate, a 3.6-ft. long weld required 14.8 min. when produced by E 6013 and E 6020 electrodes. One contact arc welding procedure did the job in 8 min. and a second in 7 min. These are savings in direct labor time of 46% and 53%, respectively.

Still other test comparisons were made between two contact electrodes and a standard E 6020 electrode. The test involved making a T-joint on plate 4 by ⅜ by 2 in., depositing 5/16-in. horizontal fillets on each side of the joint. The current was 425 amp. a.c.

In making a downhand butt joint, 45-deg. included angle, ½-in. plate was welded with conventional and contact electrodes, as follows:

Conventional
Layer 1—3/16-in. E 6011
Layer 2—1/4 -in. E 6020
Layer 3—1/4 -in. E 6020
Layer 4—1/4 -in. E 6020
Total Elapsed Time, 203 sec.

Contact
Layer 1—5/32-in. C-20
Layer 2—3/16-in. C-20
Layer 3—3/16-in. C-20
Total Elapsed Time, 147 sec.

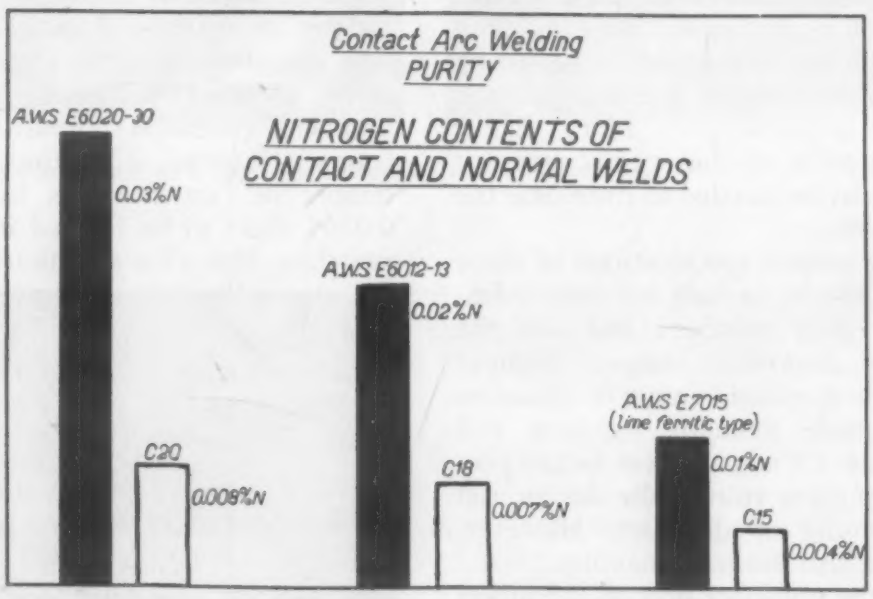
An interesting job involved the welding of an automotive pump cover. The job is set up on a rotating jig with a variable speed drive. The operator merely holds the electrode (generally E 6012) in one spot and deposits a circular fillet around the rim. In a test, 3/16-in. C-18 was used and speed of rotation was increased to 40 to 50%. The resulting weld was better appearing than that resulting with standard rod at slower speeds.

These examples will show that at least from the standpoint of speed and time savings, contact arc welding is worth investigating for welding mild and low alloy steels.

Production Test Comparing Cost of Deposited Weld Metal with Contact and Conventional Electrodes of E6020 Class

	E-6020 (¼ in.)	Contact 20 (¼ in.)	
Current	350 amp.	400 amp.	450 amp.
Electrodes Used per Hr. (50%) Duty Cycle	5.25 lb.	7.4 lb.	9.0 lb.
Cost of Electrodes per Hr.	$0.50 ($9.5/lb.)	$1.48 ($0.20/lb.)	$1.80 ($0.20/lb.)
Wages per Hr.	$1.50	$1.50	$1.50
Cost of Current per Hr. (2¢ per Kwh., 50% Duty Cycle)	$0.12 (6 Kwh.)	$0.16 (8 Kwh.)	$0.20 (10 Kwh.)
Total Direct Charges per Hr.	$2.12	$3.14	$3.50
Pounds of Metal per Hr. (50% Duty Cycle)	3.84 lb.	5.68 lb.	6.81 lb.
Direct Charge Cost per Lb. of Deposited Weld Metal	$0.55	$0.55	$0.51
Total Direct Charges per Hr.	$2.12	$3.14	$3.50
Overhead at 150% of Labor	$2.25	$2.25	$2.25
Total Charges per Hr. (Including Overhead)	$4.37	$5.39	$5.75
Total Cost per Lb. of Deposited Weld Metal	$1.14	$0.95	$0.84
% Saving	—	16.7%	26.3%

	Electrode Size	Welding Time (Min.)	Weld Length (In.)	
C 20	¼ in.	3.065	53.9	
C 15	¼ in.	3.480	42.0	
		Deposition Efficiency	Lb.-Hr.	Arc Speed (Ft./Hr.)
C 20	¼ in.	74.0%	12.42	63.6
C 15	¼ in.	70.8%	11.94	61.5
E 6020	¼ in.	69.9%	7.26	32.3



Less nitrogen is absorbed by weld metal when using contact electrodes.

Tool and Temper Know-How Solves Forming Problems on Copper Alloys

by P. B. TURSI, Riverside Metal Co.

Frequently poor material quality is unjustly cited as the cause for rejects, which, in reality, are the result of incorrect specifications of the forming tools.

● WHEN THE FORMING PROCESS used to shape phosphor bronze or nickel silver sheets, strip or wire produces split or crack parts, the first thought for correcting this adverse condition is to reject the material as poor quality. However, in many cases material quality is not the cause, and the problem may never be solved by simply re-ordering the alloy to the same specifications. More likely, modification of the specifications or tools may be needed to overcome the difficulty.

The proper specifications of these alloys should include not only chemistry (alloy number) but also the equally important temper. Temper must be specified because it influences the tensile strength, hardness and ductility. Of course, these factors play an important role in the design and functioning of the part. However, temper also limits formability.

As the phosphor bronze and nickel silver alloys are cold rolled to produce increasing temper (higher tensile strength and hardness), the ductility decreases. Therefore, forming a part with a sharp fillet or equally severe bending or twisting becomes more and more difficult as the temper increases. And, if the designer is concerned only with tensile strength or hardness and not with ductility, the specifications may be unrealistic because the part cannot be made. On the other hand, if the designer would consider the forming operation as well as the functioning of the parts when drawing up the design and specifications, much time and effort could be saved in production. Here are two examples to illustrate.

A manufacturer of telegraph equipment specified nickel silver alloy number 7 (nominal composition—55 copper, 18 nickel, 27% zinc) with a temper of "six numbers hard" for 0.0265 sheet to be formed into jack switches. This alloy specification calls for the following average physical properties:

Tensile strength	108,000 psi.
Yield strength	84,000 psi.
Hardness (Rockwell) ..	97

During the forming operation, cracks occurred at the two positions on the switch noted in Fig. 1. Upon investigation, The Riverside Metal Co. found that the forming operation was too severe for that particular alloy specification. Therefore, the quality of the material was not at fault, and the same alloy was recommended, but with a temper of only "four numbers hard." The average properties are:

Tensile strength	100,000 psi.
Yield strength	83,000 psi.
Hardness	94

The cracking problem was solved.

In contrast to improper temper specifications, here is an example in which an electric company drew up the correct alloy specifications, but still ran into trouble. The specification called for Grade "A" spring temper phosphor bronze wire. This wire was coiled into an open-wound spring.

During the coiling operation unusual breakage occurred in the looped section. Investigation proved that the material was sound, and further, all failures occurred at one particular point on the loop. Final investigation proved that the tools were shearing the wire.

The shearing action can be followed by referring to the photographs. In Fig. 2 it can be seen that the tool cut into the wire on one side (A) and then bumped it on the other (B), which causes the wire to be sheared. Fig. 3 is the longitudinal section through the center at 3A and shows the cracks appearing almost half-way through the wire. The tools were altered to eliminate this severe bumping, and the breakage was eliminated.

Thus, it can be seen from these two examples that a thorough study of the whole forming process is often necessary to arrive at a solution for the cause of rejectable material.

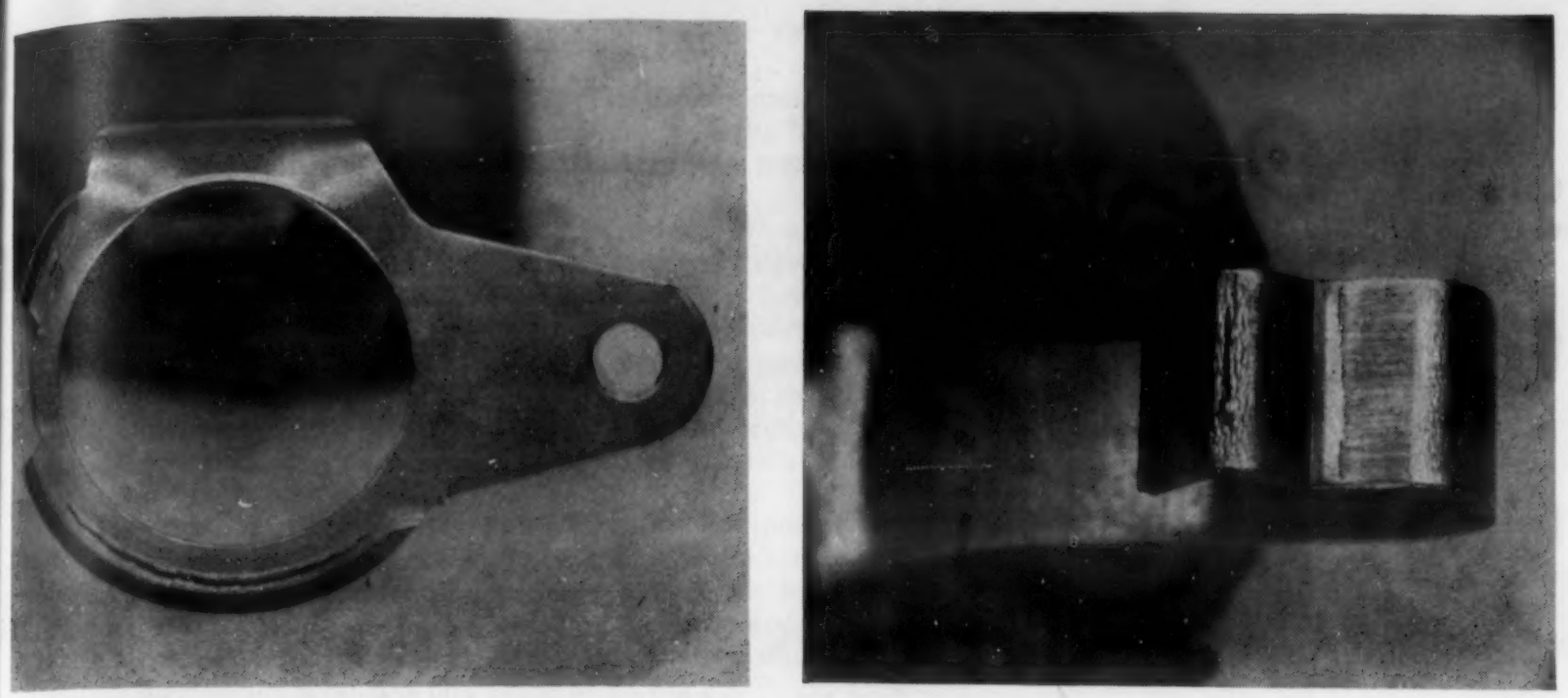


Fig. 1—Cracks developed in this jack switch during the forming operation.

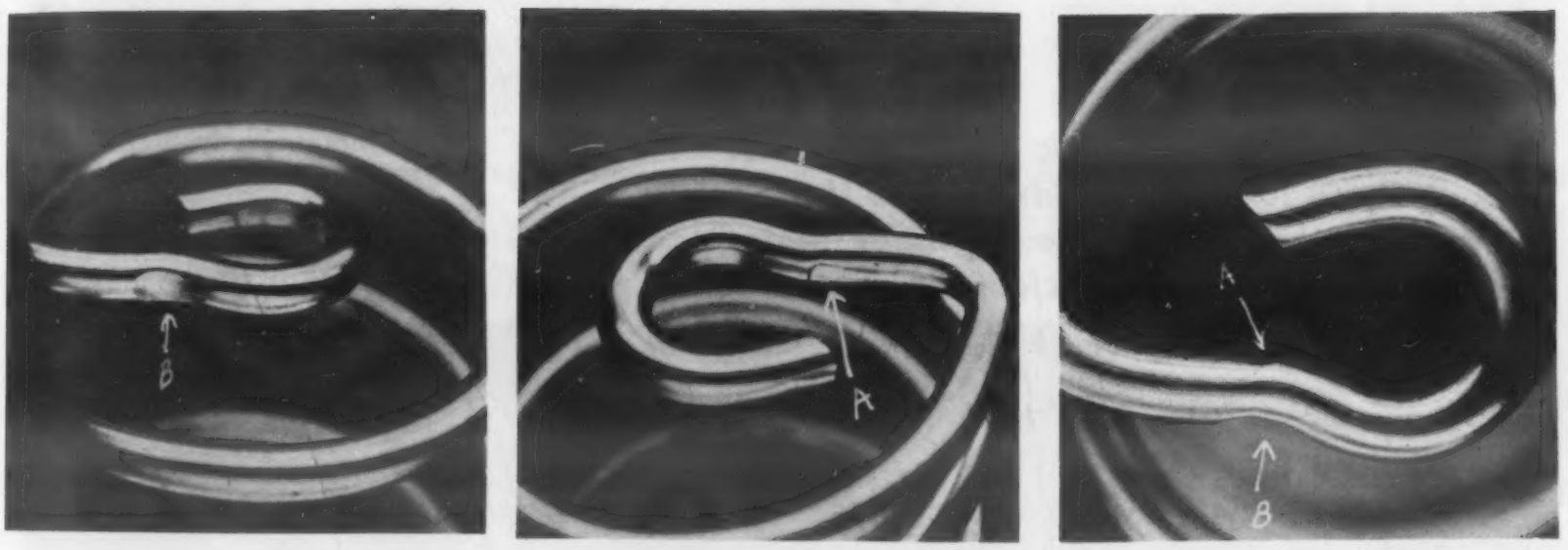


Fig. 2—Three views of a phosphor bronze wire that cracked during coiling operations.

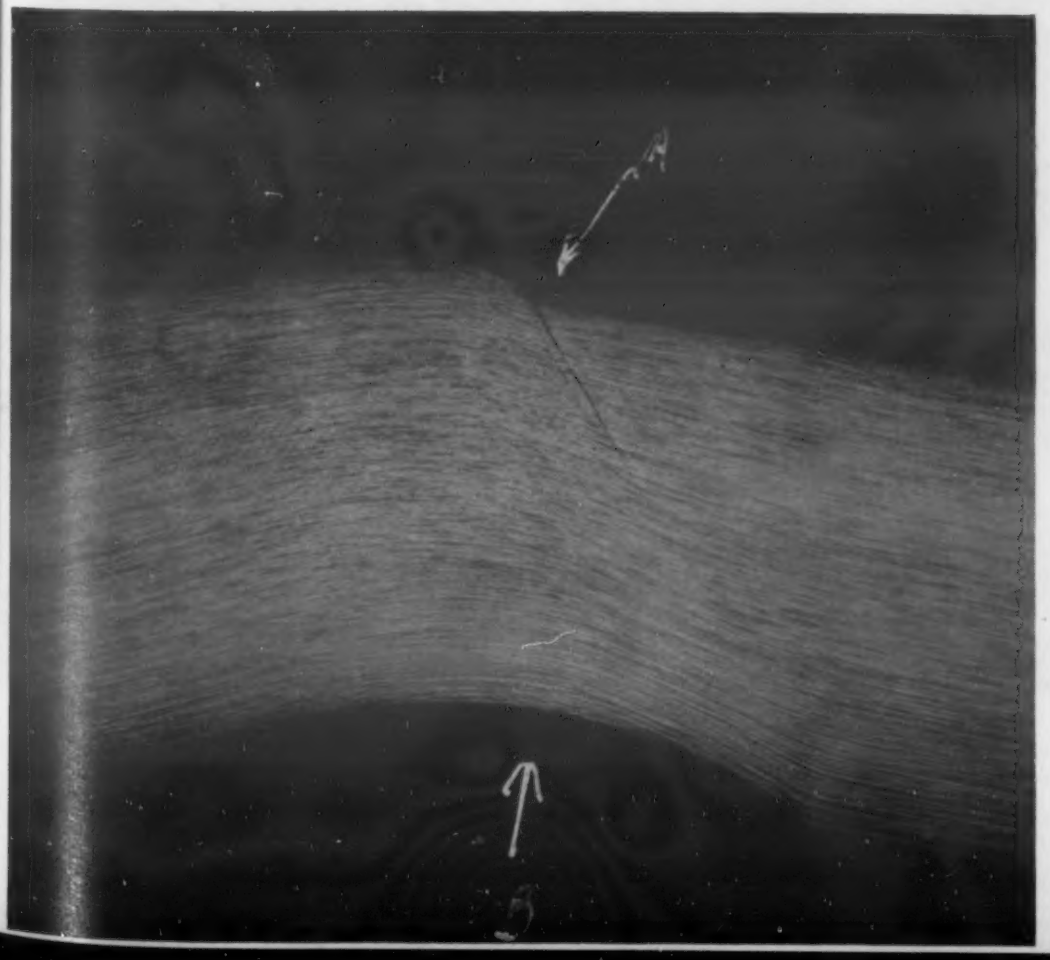


Fig. 3—A longitudinal section through the wire shown in Fig. 2 reveals crack running half-way through the wire.

Salt Baths Perform Variety of Cleaning Jobs on Most Metals

by JOHN B. CAMPBELL, Associate Editor, Materials & Methods

Non-electrolytic salt baths boast a long list of advantages that make them attractive for many metal descaling and cleaning applications.

• WHEN NON-ELECTROLYTIC salt bath descaling of stainless steel was first introduced commercially back in 1941, it found immediate application in the mills of stainless producers. In the last nine years salt bath descaling has also been adopted by many stainless fabricators throughout the country. Furthermore, stainless steel is only one of many types of metals and alloys now descaled in these baths. In addition, cleaning applications other than descaling have been discovered for this process and, in some cases, it is used to perform cleaning and heat treating jobs simultaneously.

The upshot is that a wide variety of cleaning jobs, on a wide variety of materials, can now be handled by these salt baths. It is the purpose of this article to review briefly the advantages and limitations of salt bath descaling and to indicate the scope of its current and potential applications in metals fabrication. Only non-electrolytic, single-bath processes will be discussed in this article.

In salt bath descaling, the metal is first immersed in a molten salt bath at a fairly high temperature. The salt bath contains an oxidizing or reducing agent which reacts with the scale on the metal surface, preparing it for easy removal. The immersion period ranges from 15 sec. to 30 min., depending upon the material, the nature of the scale, the size of the part, and upon the particular bath used. The metal is then quenched in cold water; the steam that is produced blasts off most of the altered and loosened scale. A short dip of 2 to 5 min. in hot sulfuric or hydrochloric acid removes the last of the scale and cleans the surface. A water rinse follows. For some applications, the acid dip is not necessary; for others, a nitric acid dip for bleaching or passivating is required.

Two different descaling salt baths in wide use at the present time are the royalty-free sodium hydride bath, developed by E. I. du Pont de Nemours & Co., Inc., and the Virgo Salt bath, developed by Hooker Electrochemical Co.

The sodium hydride bath is a mixture of caustic soda (sodium hydroxide) and from 1.5 to 2.0% sodium hydride at 700 to 800 F. Its action is due to the sodium hydride, which reduces the oxides in the scale to the metallic state, turning the scale into a loose, flaky mass. The sodium hydride is produced in a "generator" partially immersed in the caustic. Dissociated anhydrous ammonia is bubbled through the caustic in the generator and, at the same time, bricks of sodium are fed in the top. The hydrogen in the dissociated ammonia combines with the sodium to form sodium hydride, which diffuses out through the caustic carrier. A number of different methods of heating are in use but immersed electrode furnaces and gas-fired radiant tube furnaces are the two types most widely used.

The Hooker Process differs in the nature of its reaction and in operating temperature. The Virgo Salt bath is also caustic but, instead of a reducing agent, it contains an oxidizing agent as yet unnamed by the company. Thus, the oxides in the scale are converted to higher, more acid-soluble forms. Formation of higher oxides causes the scale to swell up and away from the metal underneath; loosening also results from cracks in the scale caused by unequal thermal expansion and contraction of metal and scale during the process. Operating temperature of the Virgo Salt bath is 850 to 1250 F or higher, depending upon the particular application.

The differences in temperature and mechanism of reaction between the two processes are reflected to some extent in their general applicability. But it is evident that these two descaling methods are quite similar in their end results and should be considered together.

Advantages

Although these salt baths are used for purposes other than descaling, it is this function for which they were developed and are most used. The advantages in descaling offered by these baths over other methods can be summarized as follows:

1. Descaling time is reduced considerably, from hours to minutes in some cases.

2. The 2 to 3% metal loss suffered in acid pickling is avoided. This is important not only for economic reasons but also for maintenance of close dimensions.

3. Pitting or selective attack of the

etal is eliminated, thus cutting fin-hing costs.

4. The need for baking steel to void hydrogen embrittlement caused y pickling is avoided.

5. The problem of disposing of ent pickle liquor is considerably re-uced, as much lower quantities of id are required.

6. Primarily, scale is not removed n the caustic bath, but merely altered nd loosened; therefore, the bath does ot fill up with sludge. This is par-cularly true of the Virgo Salt bath. lthough the sodium hydride bath as a greater tendency to fill up with udge, the reduced scale does not ontinue to react with and thereby xhaust the bath.

7. No undesirable products are rmed in the bath that makes its re-lacement necessary.

8. Tanks, baskets and fixtures need ot be made of alloy steels.

9. Generally, little danger arises om leaving the metal in the bath oo long; therefore, different types of etals can be processed simultane-usly and flexible scale-removing se-uences can be worked out. Since the Hooker Process involves an oxidizing eaction, its latitude in this respect is less than that of the sodium hydride process.

10. The sometimes undesirable cold working resulting from mechanical methods of scale removal is eliminated.

11. All surfaces to which liquid can flow are uniformly descaled. Therefore, complex parts having small recesses or severe undercuts can be descaled without overexposing open surfaces or underexposing removed corners. Such uniformity is not possible with shot blasting and other mechanical methods.

12. Electrical equipment is not required except where electric furnaces are used to heat the baths. Electrolytic descaling processes are particularly impractical for stainless steel because of its high electrical resistivity.

13. Each bath is regenerative to a certain extent. When sodium hydride picks up oxygen from the scale, it forms caustic soda so that few caustic additions are necessary to replace "drag-out." And the oxygen lost to the scale by the Virgo Salt bath is regained through exposure to the atmosphere.

14. A minimum of skilled labor and maintenance is required.

Limitations

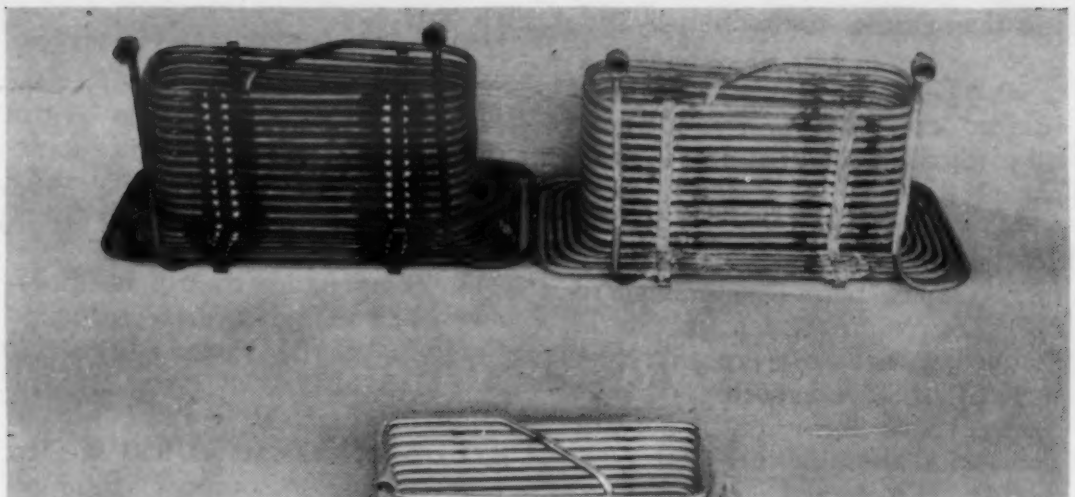
The different reactions and temperatures involved make the control problems of the two processes somewhat different. But generally these problems and other limitations can be listed about as follows:

1. Temperature control is important. The sodium hydride reduction proceeds at 700 F, the Virgo Salt oxidation at 930 F. Actually, the Virgo Salt bath can be run as high as 1250 F and as low as 850 F. The higher temperatures speed up the reaction and make possible simultaneous tempering or stress-relieving of alloys, whereas the lower temperatures are useful where such heat treatment is not desired. The sodium hydride bath, however, cannot be run above 800 F without excessive loss of the hydride.

In both baths a coating of caustic solidifies about the cold metal when it is first immersed; the lower the bath temperature, the slower this layer is to liquefy.

2. The baths cannot be used where their relatively high temperatures would cause undesirable heat treatment of the alloy. Fortunately, these

The propeller hub and the welded stainless steel cluster segment of Beechcraft Model 18 collector ring are descaled by the sodium hydride process. (Courtesy Beech Aircraft Corp.)



Soda water cooling coils are shown after silver brazing (top right), after salt bath immersion and water quench (top left), and after acid dip, passivating and electropolishing. (Courtesy Bastian-Blessing Co.)

bath temperatures are lower than the transformation points of most alloys. This is more true of the sodium hydride bath than of the Virgo Salt bath.

3. For most economical operation, these baths must be used continuously. Intermittent use involves keeping bath temperature at least above the solidification point (about 605 F) or shutting down the bath and incurring the expense of remelting and reheating the caustic.

4. The tanks must hold enough fused salt so that the temperature does not fall too low when cold metal is added. In some cases this means fairly large equipment, but usually a tank large enough to hold the work is adequate. Where the problem does arise, there are two possible solutions: preheating the metal, or using a continuous installation which eliminates sudden heat losses.

5. For a few materials, particularly high-phosphorus bronze in the case of the sodium hydride bath, the maximum allowable immersion time is rather critical. As implied previously, maximum immersion times for the Virgo Salt bath are generally more critical than for the sodium hydride bath because of the difference in the nature of the reaction.

6. Water must not be allowed to come into contact with the molten caustic soda. Therefore, the metal must be dry before immersion; this is sometimes assured by preheating the metal. The treated metal must also be lowered carefully into the quench so that no flying water hits the caustic.

7. In the sodium hydride process, it is also necessary to keep water away from the sodium bricks. And the free hydrogen gas produced in this process is burned continuously to prevent dangerous accumulation.

8. For best results, unusually large amounts of surface contaminants, such as dirt, grease and oils, should be removed previously by solvent degreasing or aqueous alkaline cleaning.

Applications

In general these salt baths can be used on all materials except those which react with fused caustic soda or have physical characteristics adversely affected by the operating temperatures. Since aluminum and magnesium react vigorously with the sodium hydride bath, the process is not suitable for treating alloys composed chiefly of these metals. Aluminum, however, does not react with molten Virgo Salt. Sometimes alloys which contain fairly large percentages of reactive metals can be treated if satisfactory descaling results can be accomplished during a short treating cycle. Obviously metals which have melting points below bath operating temperatures cannot be processed; these include lead, tin and cadmium. Nevertheless, a wide range of metals and alloys can be processed. These baths are now being used commercially on a variety of carbon and alloy steels, as well as alloys of copper, chromium, cobalt, tungsten and titanium, and on clad metals.

In addition to loosening metal oxides, both salt baths can be used fo desanding castings. In the case of th sodium hydride process, the molte caustic, sodium hydride and sand re act to form a sodium silicate accom panied by the evolution of hydroge Many of these sand particles woul not be contacted by the caustic wer it not for simultaneous reduction o the scale. However, because of th large quantity of sodium hydride con sumed in this process and the evolu tion of hydrogen, the process is rec ommended only for removing th final traces of sand that remain fol lowing primary sand removal b sandblasting or shotblasting, etc.

The Virgo Salt also reacts wit sand to form sodium silicate whic precipitates as a sludge, and the ac tion of the bath is accelerated by it oxidation of the scale. In this proces the surfaces of castings are simul taneously degraphitized by oxidation

The applications of these salt bath can be summarized about as follows They are suitable for both ferrous and some nonferrous metals. They can be used for descaling in the prime pro duction of steel wire, bar, sheet, strip and tube. They can be used for de scaling in the fabrication and proces ing of castings, forgings, stampings and brazed or welded parts. With acid dip, they can be used as a step prior to plating, hot dip coating or enameling. Without acid dip, they can be used as a step prior to gal vanizing or for inspection prior to machining or further processing. The sodium hydride process is suitable where simultaneous heat treatment in the range from 700 to 800 F is de sired, whereas the Hooker Process is suitable where simultaneous heat treatment in the range from 850 to 1250 F is possible. Both baths can be used to remove sand from castings, although the Hooker Process is to be preferred where degraphitization of surfaces is desired.

Some Case Histories

The following brief case histories should demonstrate the current and potential applications of these salt baths and the extent of the advantages to be derived from their use.

Alloy Steel and Bronze Assemblies —The post-war landing gear manufactured by Beech Aircraft Corp., Wichita, Kan., was designed almost entirely for silver brazing. This made it necessary to find a simple, economical cleaning method for effective removal of mill and heat treat scale.

This problem has been solved by the sodium hydride process. The com-

pany is using this bath primarily to descale alloy steel and bronze assemblies before silver or copper brazing. However, the process is also being used on most of its stainless steel weldments, on normalized steel forgings prior to machining, and on many parts before electroplating. The sodium hydride treatment is preceded by welding, heat treating and, in some cases, machining and silver brazing. Stainless steel weldments and parts to be electroplated are given an acid dip, but silver and copper brazing are done immediately following the water quench.

In the case of the stainless steel weldments, cleaning and rework time have been reduced considerably and a more attractive part results from lack of pitting. The cost saving over sand or shot blasting is estimated at about 50%. According to the company, many of the other operations mentioned would have been extremely difficult without the sodium hydride bath.

Stainless Steel Assemblies—The Virgo Salt bath is being used by Bastian-Blessing Co., Chicago, to remove oxides resulting from brazing or welding stainless steel assemblies. These assemblies are beverage dispensing and soda fountain equipment, fabricated by silver brazing, spot welding or Heliarc welding.

Previously, this company's engineers had been unable to remove effectively oxides formed during brazing or welding operations by any of the pickling solutions used in the plating department. The desired sequence of operations was silver brazing (or welding), pickling, then electropolishing to eliminate all costly polishing and buffing. It was therefore necessary to find some way to convert the oxides to a form that could be removed by a cheap, simple pickle. With the Hooker Process now in operation, only a brief acid dip is required; this is followed by electropolishing and, finally, passivating.

In addition to removal of oxides after joining, this company found that the bath aids in the removal of the glass-like flux that remains after silver brazing and the greenish chromium oxides often found inside tubing.

Small Carbon Steel Parts—United-Carr Fastener Corp., Cambridge, Mass., is using the sodium hydride bath to descale and temper small, intricately-shaped fasteners of SAE 1020 steel prior to plating. These parts include closure buttons for tubular furniture, dress snaps, automobile fittings, radio tube clips, electrical fuse holders, lock-type nuts, and many other types of fasteners.

The bath was installed primarily to eliminate the hydrogen embrittlement resulting from acid pickling. The expected results have been achieved and, on deeply recessed parts, better plates are being obtained than were ever obtained after pickling. Parts are now cleaned in one-fourth the time formerly required, and a net cost saving of 75% has been realized. Operations in the heat treatment department have also been reduced since tempering is now done simultaneously with descaling. This tempering is carried out at about 650 F.

Since this company's operations do not permit plating directly following the cleaning operation, parts which have been quenched and rinsed after salt bath treatment are dipped in cold 2% sodium cyanide solution. Before plating, the parts are rinsed and given the usual short acid dip.

The salt bath is also being used to remove scale from heat treated Type 430 steel screws without impairing hardness. The treated screws require no acid treatment since a 20-min. tumbling produces a bright passivated surface. Absence of acid attack results in threads of greater dimensional accuracy.

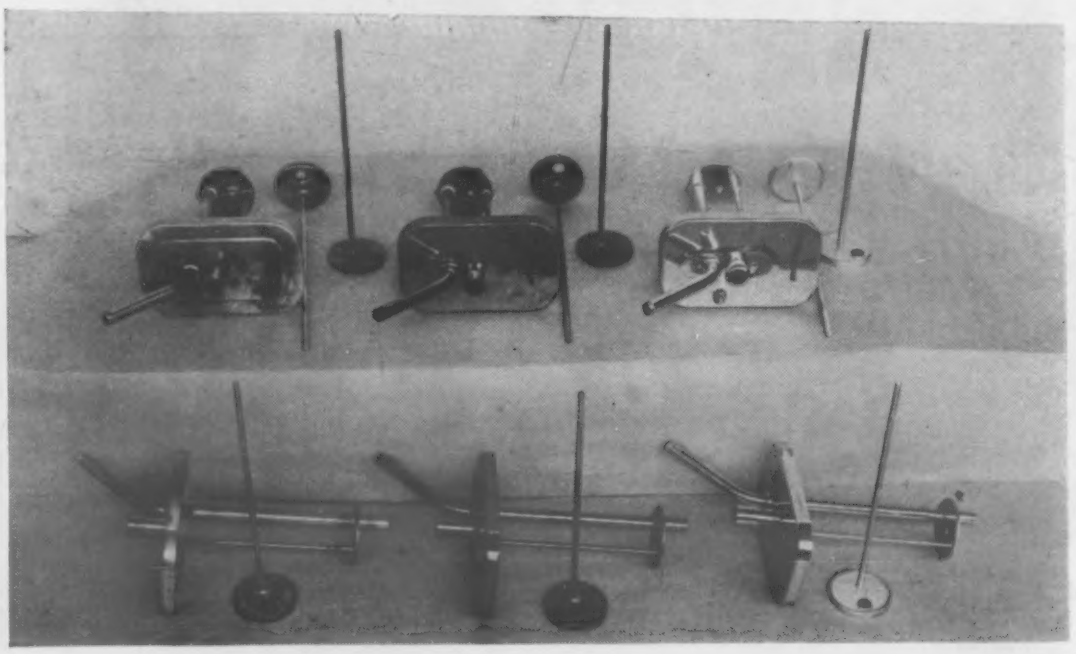
Cobalt Precision Castings—The Hooker Process is being used by Westinghouse Electric Corp., East Pittsburgh, to remove the small amount of investment (silica) which adheres to precision castings, in addition to the oxide film formed in the mold. Cobalt-base alloy gas turbine blades, stainless steel vanes and industrial steel castings are being treated, but cobalt alloys make up the largest part of this material. Salt bath immersion immediately follows the shake-out and cut-off of individual castings (small parts are descaled before cut-off). These castings are given an acid dip and water rinse before inspection.

Investment-cast turbine blading is subject to rigid quality standards. Defects which would cause rejections are often masked when castings are cleaned by abrasive or shot blast. Thus, Westinghouse engineers sought a cleaning method which would completely remove all nonmetallic material on or imbedded in the castings.

The Virgo Salt bath, by providing a surface free of investment materials and metal oxides, makes possible much more accurate inspection than does blast cleaning. Even the most minute positive defects are not disturbed. Although there is no intergranular attack, the surface structure is visible after cleaning. Consequently, abnormal variations are immediately apparent and control of metallurgical properties is possible without destructive testing and sampling error. Furthermore, it was found that castings with deep or blind holes could not be cleaned successfully by any other means.

It is estimated that the cleaning of an average turbine blade, weighing about 5 oz., costs about 1¢ in this set-up. This figure includes materials, labor, maintenance and depreciation of equipment, and is known to be lower than a similar figure for sand

Frame and piston assemblies of syrup dispensing pumps are shown immediately after silver brazing (left), after the Hooker Process (middle), and after pickling, passivating and electropolishing. (Courtesy Bastian-Blessing Co.)



blasting.

Drawn Stainless Steel Parts—Triplhard Tool Co., Chicago, is now using the sodium hydride process primarily for stainless steel stampings and drawn parts. Originally this job shop installation was intended for the removal of heat treat scale prior to the final draw of high-speed steel, thus making finish grinding that much easier but eliminating sand blasting. Since then, large castings and all ferrous and some nonferrous metals have been treated successfully.

This company reports that many of its customers have realized considerable cost savings in the subsequent polishing of their stainless steel parts due to the absence of pitting. Bowls, sinks and other deep-drawn parts are typical of the pieces processed by this shop.

High-Carbon Steel Forgings—The Chevrolet-Saginaw Div. of General Motors Corp. is using a dual-purpose salt bath. One of the production lines manufactures bumpers and bumper brackets which are forged from SAE 1080 steel. The specification calls for accurate heat treatment and, in the case of bumpers, polishing to a high finish preliminary to chromium plating.

The brackets, after forming, are oil quenched to a hardness of 514 to 601 Brinell. Formerly, these parts were tempered in an air furnace and then pickled in acid. Now, after cleaning and drying, they are drawn and descaled in a Virgo Salt bath operating at 1050 F. In this continuous process, the parts are drawn back to 321 to 338 Brinell during an immersion time of 4½ min. A high-pressure cold water rinse knocks off the scale, and the parts are then immersed in hydrochloric acid at 160 F. Hot water and hot soluble-oil rinsings follow before assembly.

As a result of the change, this company has achieved a considerable saving in direct costs, including savings in time, in addition to eliminating some equipment and gaining floor space. Greater uniformity in hardness has also been achieved, and Bonderizing on the surface is better than that obtained after pickling. (This particular installation was described in more detail in MATERIALS & METHODS, Jan. 1950, p. 62).

Stainless Steel Parts—The sodium hydride process is being used at the Richmond, Ind. Works of International Harvester Co. chiefly for descaling Type 302 stainless steel parts, such as cream separator supply cans and top disks. The cream separator supply cans are drawn, cleaned in alkali wash and annealed before being treated in the sodium hydride bath. Following the water quench, the cans are dipped in 10% nitric acid at 170 F for passivating and washed off with water under pressure. There is one more draw and one bulging operation in the process, but no more annealing or descaling.

The sodium hydride bath was installed at the Richmond Works when supply can fabrication was transferred there from another plant. Formerly, descaling on this can had been done in an acid pickling bath. Sodium hydride was selected to avoid the corrosive effect of acid on expensive dies and equipment which, because of plant layout and the nature of the operation, must be in the vicinity of the descaling line. Another consideration was reducing the problem of acid disposal, complicated by Indiana State Law.

Since then, decreased demand for cream separators has forced a considerable cut-back in production. As a result this installation, designed for high-volume production, does not offer its original economy.

Acknowledgment

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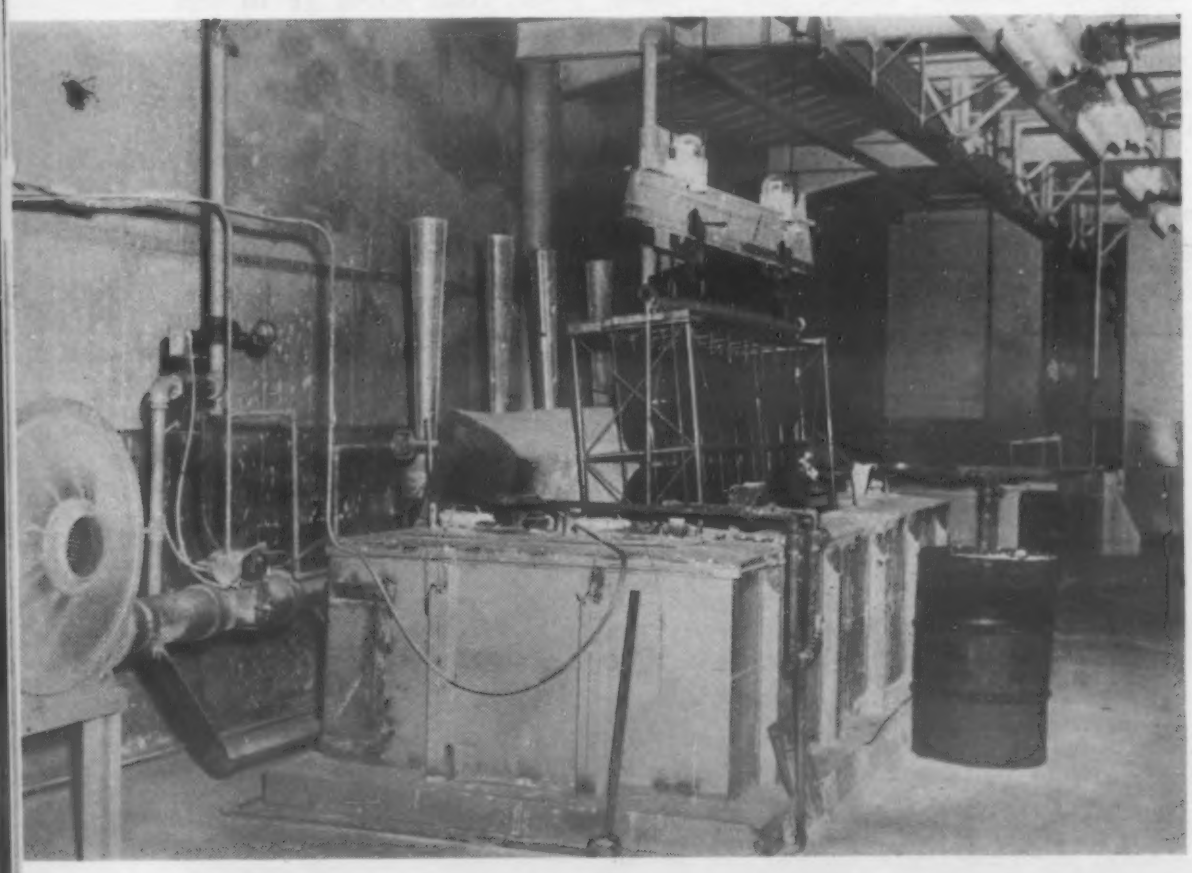
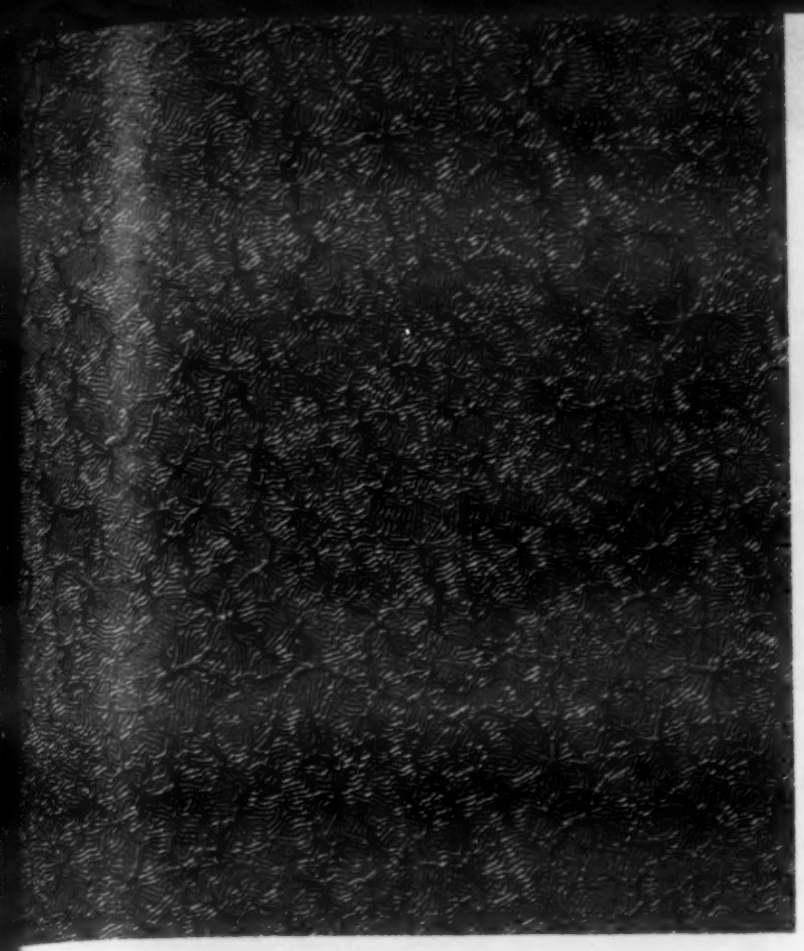
Westinghouse Electric Corp.

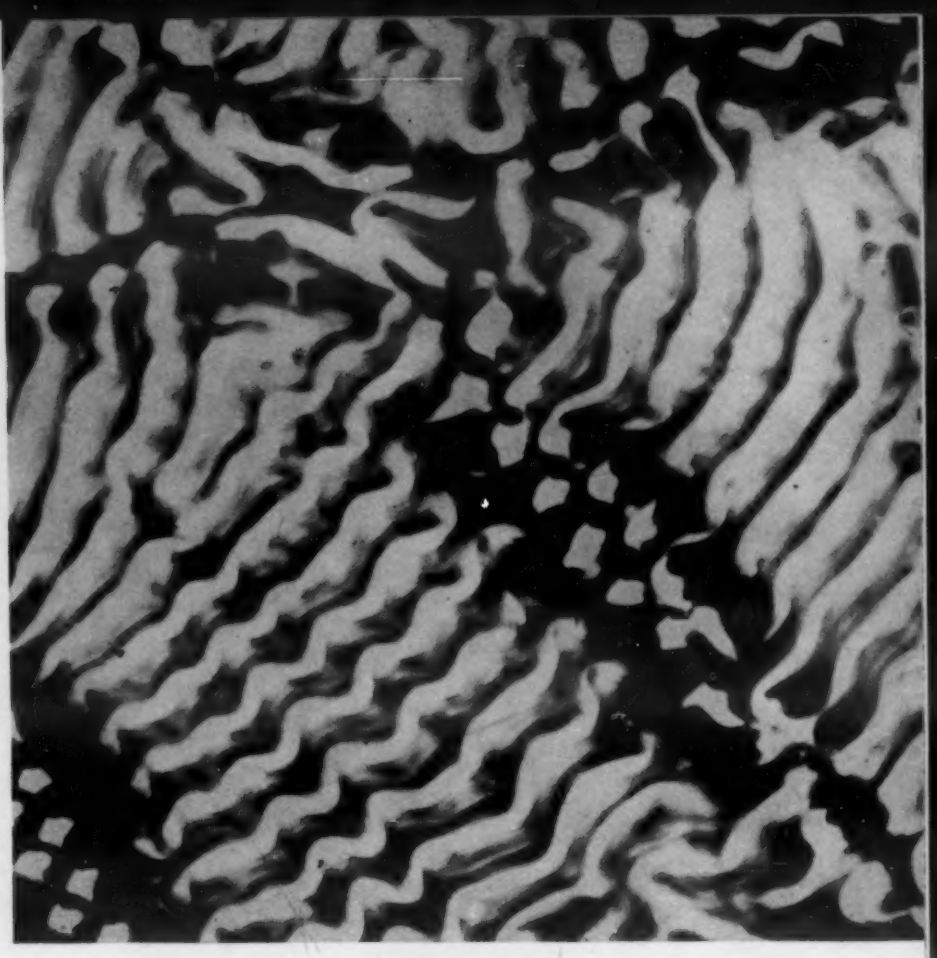


A load of fabricated parts is removed from the sodium hydride bath. (Courtesy International Harvester Co.)

This load of cream separator supply cans (after first draw) has been water quenched after salt bath immersion. (Courtesy International Harvester Co.)



A typical wrinkle-finished surface.



Enlarged photograph shows characteristic wrinkling power of tung or China wood oil.

Wrinkle Finishes Provide Attractive Durable Coatings

by **W. A. WALDIE**, Technical Director, New Wrinkle, Inc.

Enamels that are intentionally rough are available in a variety of patterns and offer special properties which can be used to advantage on many industrial and consumer products.

• THE PURPOSE FOR USE OF paints, enamels and similar finishes is to provide a protective and attractive coating over the metal, wood or other material being coated. These finishes are usually formulated with considerable care so as to provide a smooth surface coating. However, several types of coatings are intentionally made rough to obtain special properties afforded by that roughness of surface.

In one type of roughened surface a gritty material is added to the paint or similar coating to provide nonslip qualities in the surface. Two remaining types find a special attractiveness in a roughened coating, and develop it for that feature primarily. These are the crackled lacquer finishes and the wrinkled finishes. Crackled finishes are made by applying a coating that shrinks excessively upon drying, and develops large or small cracks over the entire surface, depending on the formulation. By applying the crackled finish over an undercoat of contrasting color, a pleasing two-tone effect is obtained. The second type, wrinkled finishes, maintains a continuous film, but develops tiny ridges in this film to produce the roughened effect.

Advantages and Characteristics

Wrinkle finishes have won an important place in the field of coatings, and especially in the finishing of small items in the consumer goods groups. Some of the reasons for their success are:

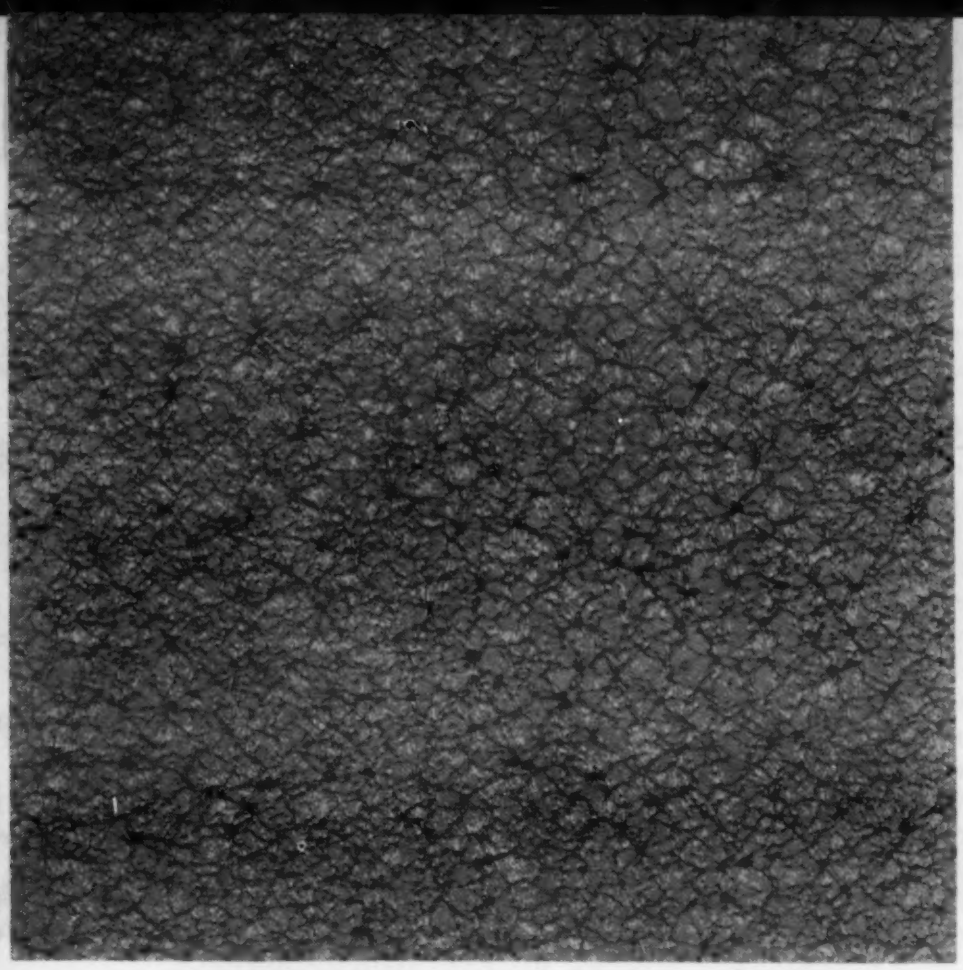
(1) The finish is very durable under conditions of ordinary wear.

(2) It can be economically applied by electrostatic spraying or other high-speed methods, and dried by modern heating equipment.

(3) Because the surface will be rough, the finishing of the undersurface can be less critical.

(4) For the same reason, the percentage of rejections because of dirt or other foreign matter in the film itself is lower.

(5) Glare is reduced or eliminated.



Two-tone wrinkle coat produced by overspattering with a contrasting color.

Enlarged photograph shows detail of a pine tree wrinkle finish.

(6) A certain degree of sound deadening is accomplished.

(7) The appearance is pleasing, and color, when used, does not vary when several different base materials are used in the same article.

(8) Surface texture is controllable within rather wide limits.

Wrinkle finishes date back to the early days of the radio receiving set, when a large manufacturer had trouble with the film softness, durability and nonuniformity of the fine finishes he was applying to his cabinets. Intensive study turned up the fact that certain combinations of ingredients in the varnish, notably with chinawood oil, always produced a puckering of the finish. It was found that this characteristic of the drying oils could be accentuated so as to produce an attractive hard, uniform wrinkling of the finish, and therefore, wrinkle varnishes were produced for radio cabinets. Later wrinkle enamels were made, and as the synthetic enamels, notably the alkyds, came into use, synthetic wrinkling agents were developed.

Wrinkle finishes are now produced as a versatile line of finishing materials, suitable for use over metal, wood, paper, oilcloth, paperboard, etc. They are, in general, one-coat finishes, but two-coat applications can be used (a) when the undersurface is porous, and a supporting undercoat is helpful; and (b) when a very light-colored finish is desired, and a clear wrinkled finish is first laid down, followed by a second coat of the desired color. Dappled finishes can be produced by overspattering.

Preparation of the surface of the work preparatory to applying the finish can be simplified when wrinkled finishes are to be used. Weld marks and minor irregularities need not be polished out, as would be necessary if a smooth coat were to be laid down. Castings can be used with a minimum of surface refinement. It is, of course, necessary to clean the surfaces of grease and oil, dirt, sand, and other foreign matter.

Color possibilities range through all the colors, and also include clear and colorless, white, or black. Metallic effects range from use of a small quantity of bronze powder to introduce sparkling particles into the surface to a full bronze finish. The latter is obtained by overspraying with a bronzing lacquer. In general, white and light tones do not show the finish to best advantage, due to the absence of highlights.

The finish is available in a range of formulations of from hard to flexible. The special flexible formulations are intended for use over paper, paperboard, oilcloth, and similar materials, where the hard finishes would crack. Hard formulations are quite durable in service.

Formulations are capable of variation to produce any of several textures. Control of the degree of wrinkle is achieved partly by varying the formulation and partly by controlling conditions during drying. Degree of gloss is also controllable. The standard finish is produced in coarse, medium or fine texture, while increasing the viscosity of the liquid material intended for application will produce such patterns as "sag," "pine tree," or "birdseye."

In sag pattern, the finish, applied in very thick coating and at rather high viscosity, is permitted to flow during the baking operation so as to form large folds in the film. This type of surface is used for large pieces, such as grave vaults. Pine tree finish is likewise produced by applying a coat of the enamel considerably heavier than for the ordinary wrinkled finish and allowing for a period of air drying before baking so that the film will not sag. The result is a wrinkled surface in which the wrinkling takes on a characteristic triangular pattern controllable as to large or small triangles by varying the formulation. Birdseye pattern, consisting of small round smooth spots distributed over the surface, is produced by adding a small amount of frosting oil to the formulation so as to develop a combined wrinkling and crystallizing effect. A preliminary bake at about 100 F for 1 hr. develops the eyes, and a period of airdrying should precede the first bake.

Applying and Drying Wrinkle Finishes

The coat can be applied by dipping, by roller or knife spreading, or

spraying, either with the hand gun automatically. Brushing is not a commended procedure, as the brush rokes tend to break up the surface ttern as it first forms. Spraying ves excellent results. Temperature the enamel should not fall below out 70 F, or the coat may be too avy, while excessively high temerature may cause loss of solvent. ir pressure for spraying should be out 50 to 60 psi. For the standard nishes the work is then given a short drying, and is moved into a hot r oven for a final bake. One hour 250 F is the usual baking schedule r standard formulations, but special rmulations can be made up to fit her baking conditions.

Baking is a necessary condition to e forming of the wrinkled surface ttern under usual plant conditions. nfra-red baking does very well, ough a special formulation is usuly necessary. Any method of heat pplication that will be uniform will sually be satisfactory. The time may e shortened by increase of temperaure, but 400 F is about the upper limit at present. At this temperature baking time will be about 15 min. It is necessary that the enamel pigments and other ingredients be selected for stability at this higher temperature, however.

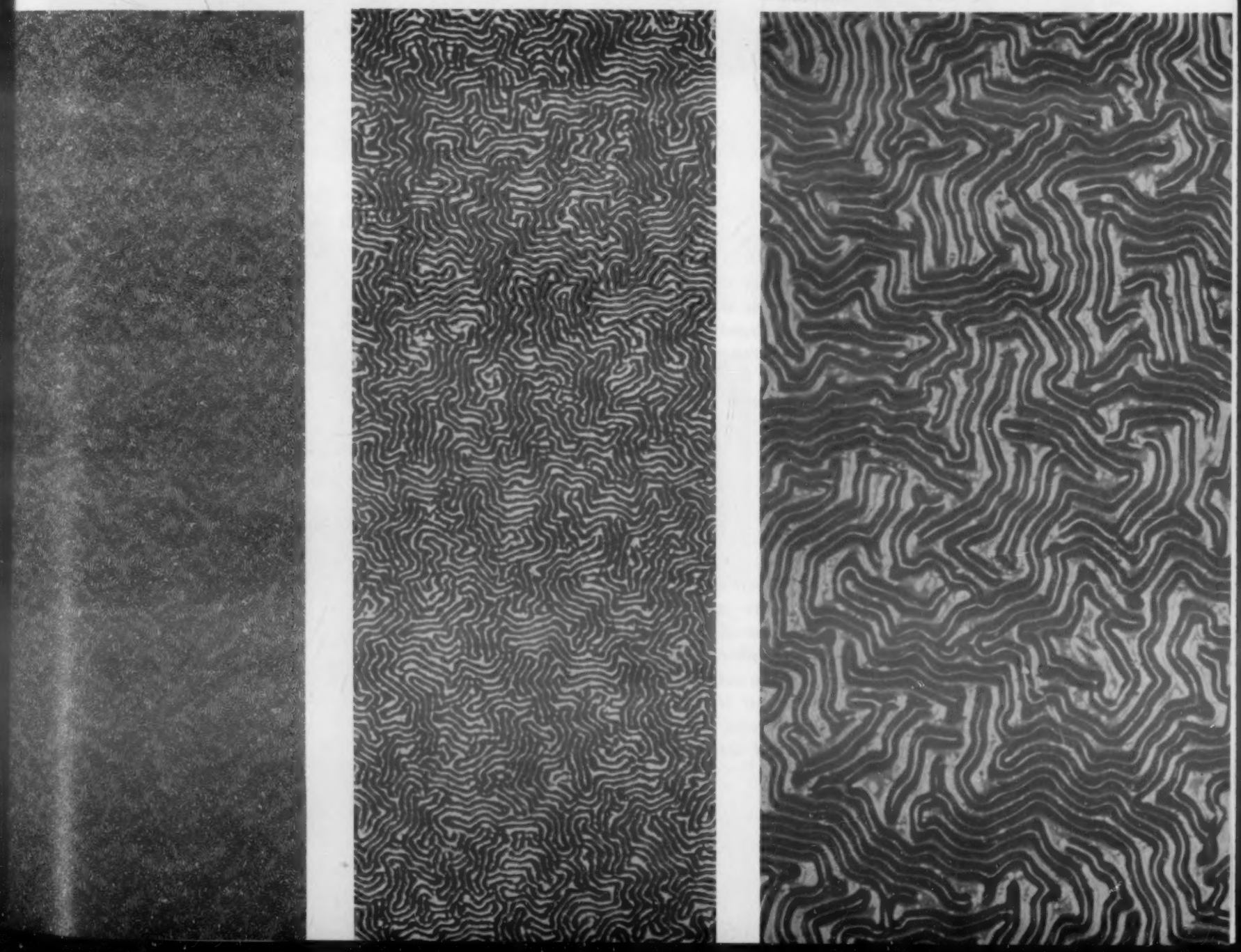
When such materials as wood, paper, paperboard, cloth or oilcloth are to be finished with wrinkling enamel, the final baking temperature must be lowered. The wrinkled texture will develop at temperatures as low as 100 F if the temperature is held uniform for 12 to 24 hr., and the humidity can be closely controlled. This means the elimination of drafts. Increasing the drying time to 150 F will permit shortening the drying time to about 2 hr.

Castings that have been cleaned but not finished frequently have small surface defects that would not affect the usability of the coating, and do not warrant expensive mechanical surface treatment. A dual process with wrinkling enamels has been developed to seal over these minor defects and finish the surfaces at low cost. A thin solution of the wrinkling finish is first used as the sealer, the casting being dipped into the liquid, and the workpiece is permitted to drain and air-dry for some minutes. A sprayed coating of the wrinkling enamel is then applied, and the piece is baked at the usual temperature.

Wrinkle enamels will air-dry with the production of the proper finish if the drying room can be sealed off from drafts, and held at a temperature of about 100 F. From 16 to 24 hr. will be required for development of the proper surface film, and any lowering of the temperature more than 10 F, even for a short time, will impair the texture of the finish. However, the durability of any air-dry finish will not equal that obtained by baking.

Wrinkled enamels and other wrinkled finishes are used on a wide variety of products, such as office equipment, bobby pins, telephone booths, air conditioning units, photographic equipment, various types of industrial instruments, household fittings, furniture, grave vaults, small novelties, clocks, and electrical devices.

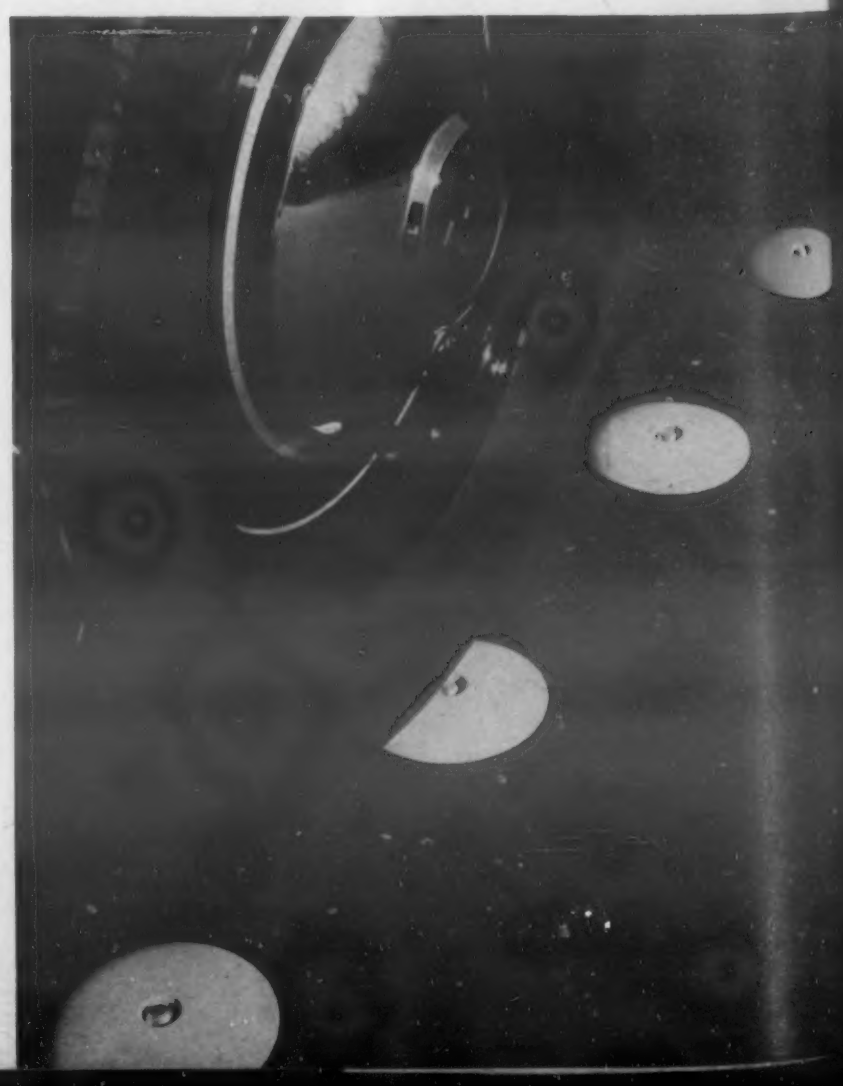
Three different uniform wrinkle textures. Left, fine texture (3X); center, medium texture (9X); right, heavy texture (9X).



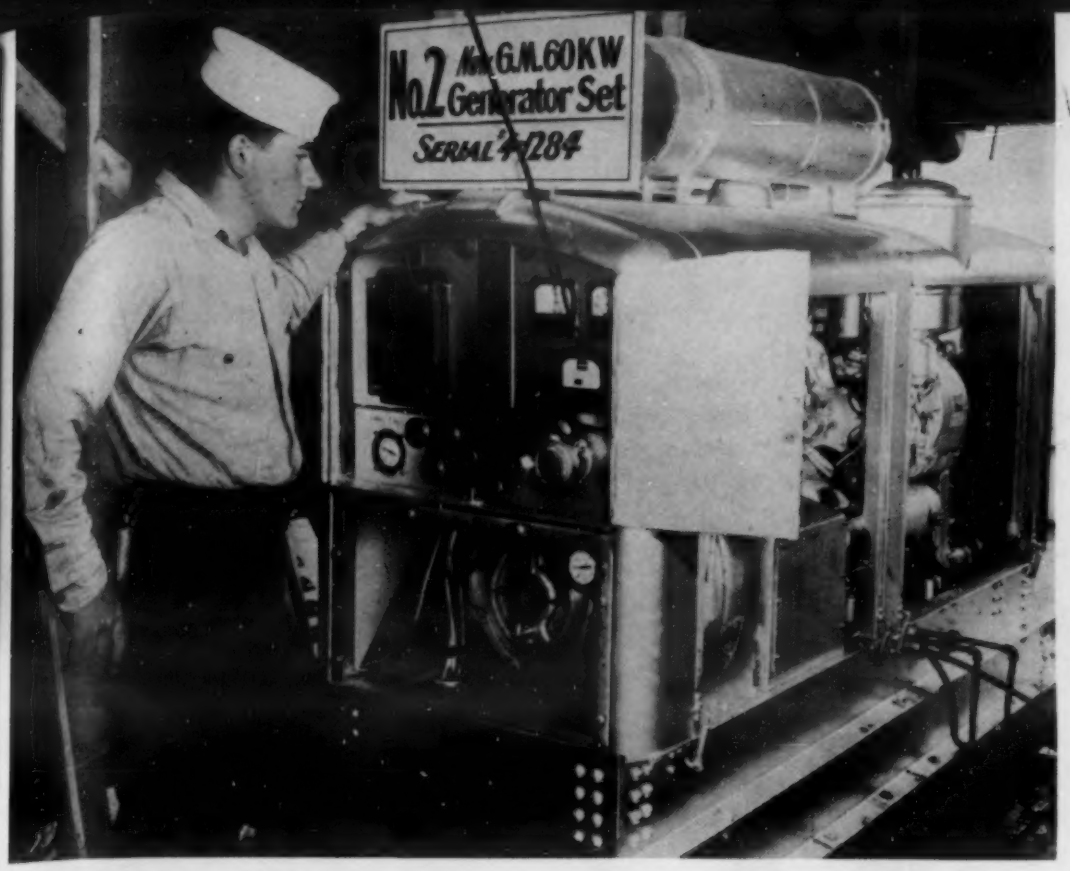
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .

ALUMINUM BOAT *Produced in both outboard and inboard models, this 14½-ft. lightweight boat is designed to take considerable abuse. Alcoa 61S-T6 alloy, recognized for its high resistance to salt water corrosion and good strength properties, is used throughout. Bottoms of the boats are equipped with wood rubbing rails for additional protection when beaching. The hull alone weighs 200 lb. and contains aluminum tanks for emergency flotation.*

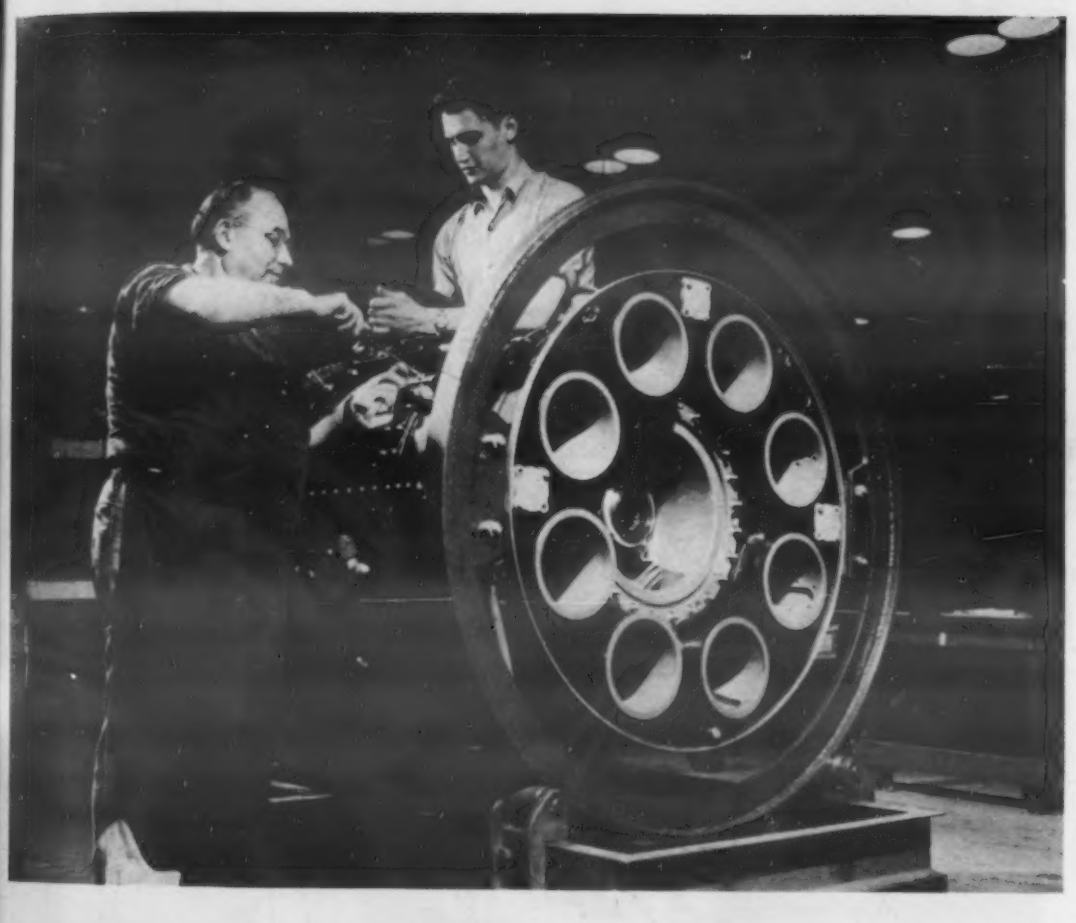


PLASTIC TRAFFIC MARKERS *Supplanting metal or concrete markers, these durable Tenite marking units eliminate seasonal painting and are highly visible in all kinds of weather. In use, they greatly reduce the cost of maintaining municipal traffic lanes and crossings, and are resistant to breakage.*



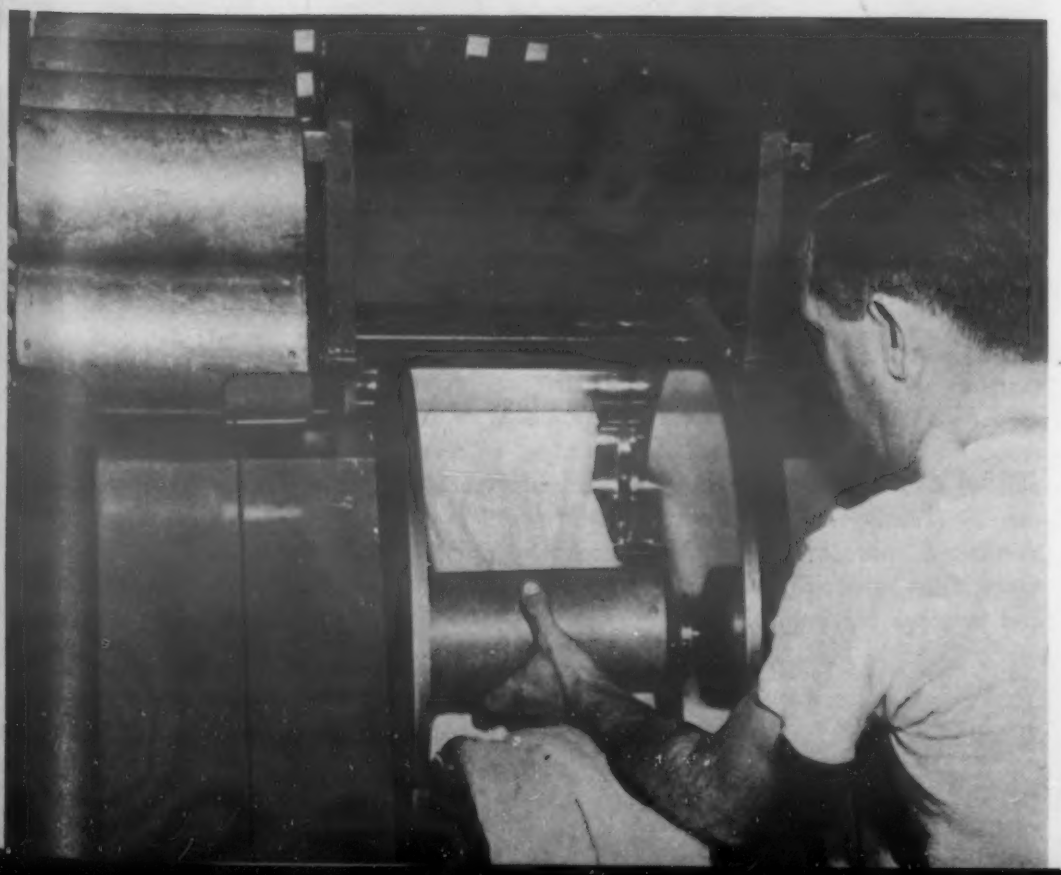
LIGHTWEIGHT ALLOY GENERATOR

Developed by the Bureau of Yards and Docks, Department of Defense, this 3,300-lb. unit weighs approximately 50% less than standard 60-kw. generators. It is powered with a high-speed Diesel engine also constructed of light metals and is insulated with silicone, thus permitting much higher temperatures than ordinary insulation. This unit runs at 1800 rpm. as compared with 900 rpm. for the old model it replaces. The generator incorporates a 60-cycle, 3-phase, 4-wire dual-voltage system capable of generating 120/209 or 240/416 volts. Test observations indicate that considerable improvement in regulation and ease of paralleling is obtained at a higher operating speed. The overall dimensions of the unit are: 107 in. long; 69 in. high; and 35 in. wide.



STAINLESS STEEL COMPRESSOR BLADES

Designed for service with the General Electric J-47 turbo jet engine, this 12-stage axial-flow compressor section compresses the air flowing into the front end of the gas-turbine power plant. Flowing at the rate of about 90 lb. per sec., more than 2½ tons of air a minute are pushed through the eight circular openings and into the combustion chambers for firing. The air leaves the compressor end of the engine at a temperature of over 450 F, thus necessitating the use of stainless steel blading in the compressor assembly.



MICARTA LAP ROLL

Developed to fit any of the standard lap winders now in use, this roll is 46 to 49% lighter than conventional units. The tough, laminated material from which the roll is made will not chip, dent, or splinter. Because of the resinous binder used, the roll is impervious to moisture and does not require a protective varnish coating. To assure a concentric roll, the micarta lap roll is put through a centerless grinder during manufacture. This grinding operation produces a roughened surface on the lap roll and results in a rapid pick-up of the lap during winding. Thus, overlapping and waste are avoided and more uniformity is given to the finished yarn.

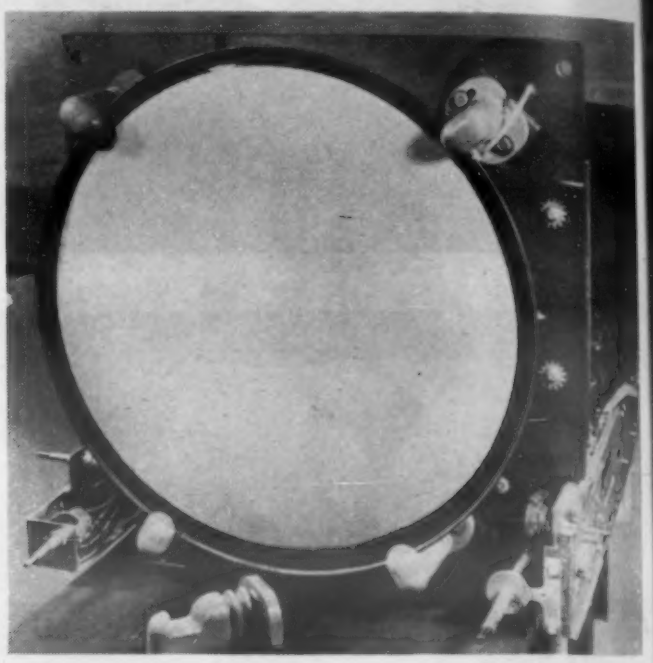
Materials at Work

PHENOLIC ELECTRICAL COMPONENTS

General purpose and low loss dielectric molded phenolic plastic products for the electrical and electronic industries are available in black, white or colors for specific product identification. These plastic parts are usually supplied as molded pieces; as sub-assemblies with staked, eyeletted, or stitched metal; or as complete assemblies of molded plastic and small metal parts.

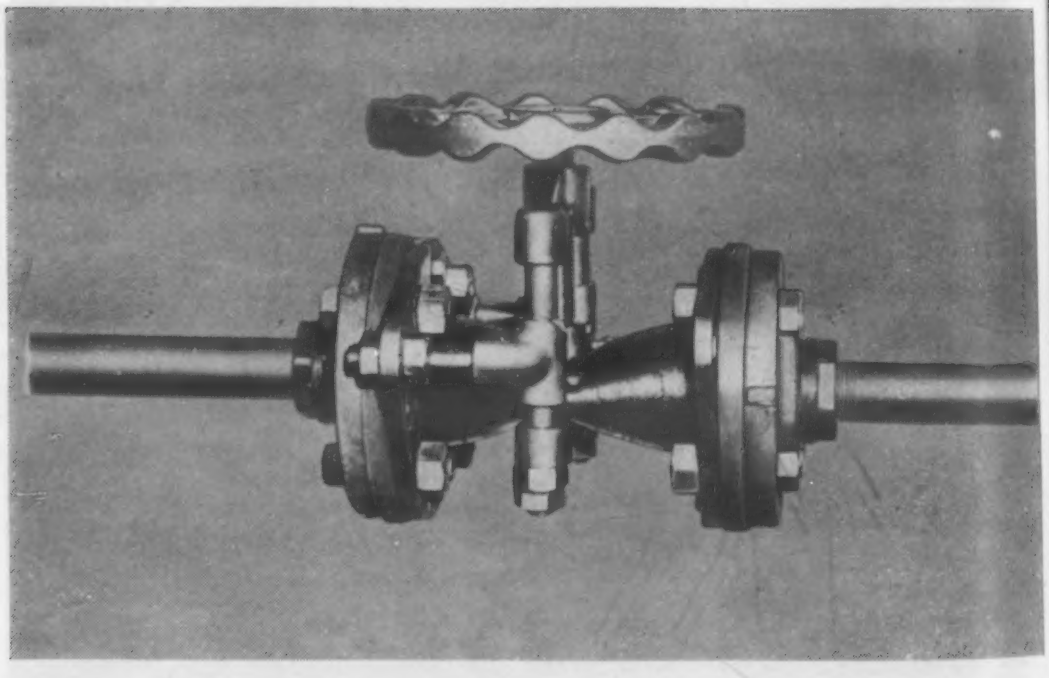
ALKYD TELEVISION BRACKET

Molded of Plaskon alkyd, this mounting bracket for a 16-in. television tube costs less than half the amount formerly spent to fabricate this part. In addition, the plastic fabrication provides superior electrical and mechanical properties. The brackets insulate the metal picture tube, carrying 14,000 volts, and assure correct mechanical support and exact position within the chassis of the set.



ALL-ALUMINUM FRYER

Reportedly the first round, seamless, all-aluminum automatic electric deep fat fryer, this unit is produced by the Burpee Can Sealer Co. The fryer is die-drawn from one piece of plate aluminum and is satin-finished to resist grease. A Chromolox heating element embedded in ceramic furnishes the heat.



RUBBER PINCH VALVE

Claimed to outwear metal when installed in pipelines carrying abrasive or corrosive mixtures, this new valve has the added advantage of being able to offset misalignment in pipes by means of its inherent flexibility. No packing or repacking is required. It absorbs vibration, eliminates "water hammer", and affords a positive seal in the closed position. Its metal parts can be refitted to new valve bodies, thereby reducing replacement costs, and it will break up galvanic action in metal lines. Valves are available in abrasive and corrosive resistant compounds: neoprene for oil resistance, butyl rubber for high heat and severe acid conditions, and pure gum stock for food and beverage conveyance.

Baked fiber glass preform is placed on the mold. (Courtesy Apex Electrical Manufacturing Co.)

New Laminating Method

Reduces Cost of Making Glass Fiber Preforms

This novel process, permitting preforms to be made directly from glass fiber in floc form, has wide possibilities for large parts of relatively simple shape.

• THE REMARKABLE STRENGTH of glass fibers, when used under the proper conditions, has made them one of the most important laminating materials for plastics. In addition to high strength, glass fibers have several other important features, including noncombustibility, imperviousness to water, excellent electrical insulation, and ready acceptance by plastics. There are several disadvantages, too, and high cost is one of these. Another is the fact that glass fibers, when woven into a fabric, require a dressing to prevent them from abrading one another where fibers cross. This dressing must be burned away before the fabric can be used as a laminating material for plastics, and burning presents a problem in handling as well as an extra operation.

Several alternatives have been evolved in studies of methods that will utilize the glass fibers without the necessity of burning off the dressing. One of these has been the use of the glass fibers as a loosely twisted yarn rather than as a woven fabric, the yarn being laid down as a swirled mat, impregnated with a resinous binder, and the laminate formed from it. Impregnated batts of the fibers have been used also. The material is somewhat more difficult to handle in either case than is the woven fabric.

Recently a new method of using the fibers in laminating has been worked out. It not only simplifies the handling of the glass fibers, but permits a preform to be made up directly from the fibers. The fibers themselves are used as a loose floc rather than as a yarn or batt.

The forming consists of sifting the loose floc over a wire mesh form, applying suction to fit the mass closely to the form, spraying with a binder, and then removing and completing the formed part. Only simple equipment is necessary.

As used at Apex Electrical Manufacturing Co., Cleveland, the process starts with bundles of stranded glass fibers, cut to a uniform length of about 2 in. The bundles of loose fibers, designated as chopped strand, are first placed against a device resembling a cotton gin, in which a drum covered with hooks pulls the fiber bundles apart and deposits the fibers, without orientation, on a belt conveyor. They are moved on the conveyor to the machine in which the preforms are made.

The largest part made of glass-reinforced plastic is a water-balance ring for a washing machine. It is 2 ft. in dia., 1 ft. high, and 1/16 in. thick. The form over which the preform is made is a steel mesh cylinder having the shape of the finished part, and with a connection to a vacuum pump from inside the form. The chopped strand is permitted to sift down over the form, and the vacuum carries it against the mesh so that a layer of glass fibers is built up.

A thermosetting binder in liquid form is next applied to the mat of fibers as the vacuum holds it in position around the mesh. The binder is compatible with any of the polyester resins, so need not be removed before application of the plastic component. Some caution must be used in choosing the binder, however, as certain phenolics may inhibit the cure of several types of polyesters. The resin to be used should be specified in ordering the binder. Thermoplastic binders, made over a styrene base and compatible with the polyester resins, are also available.

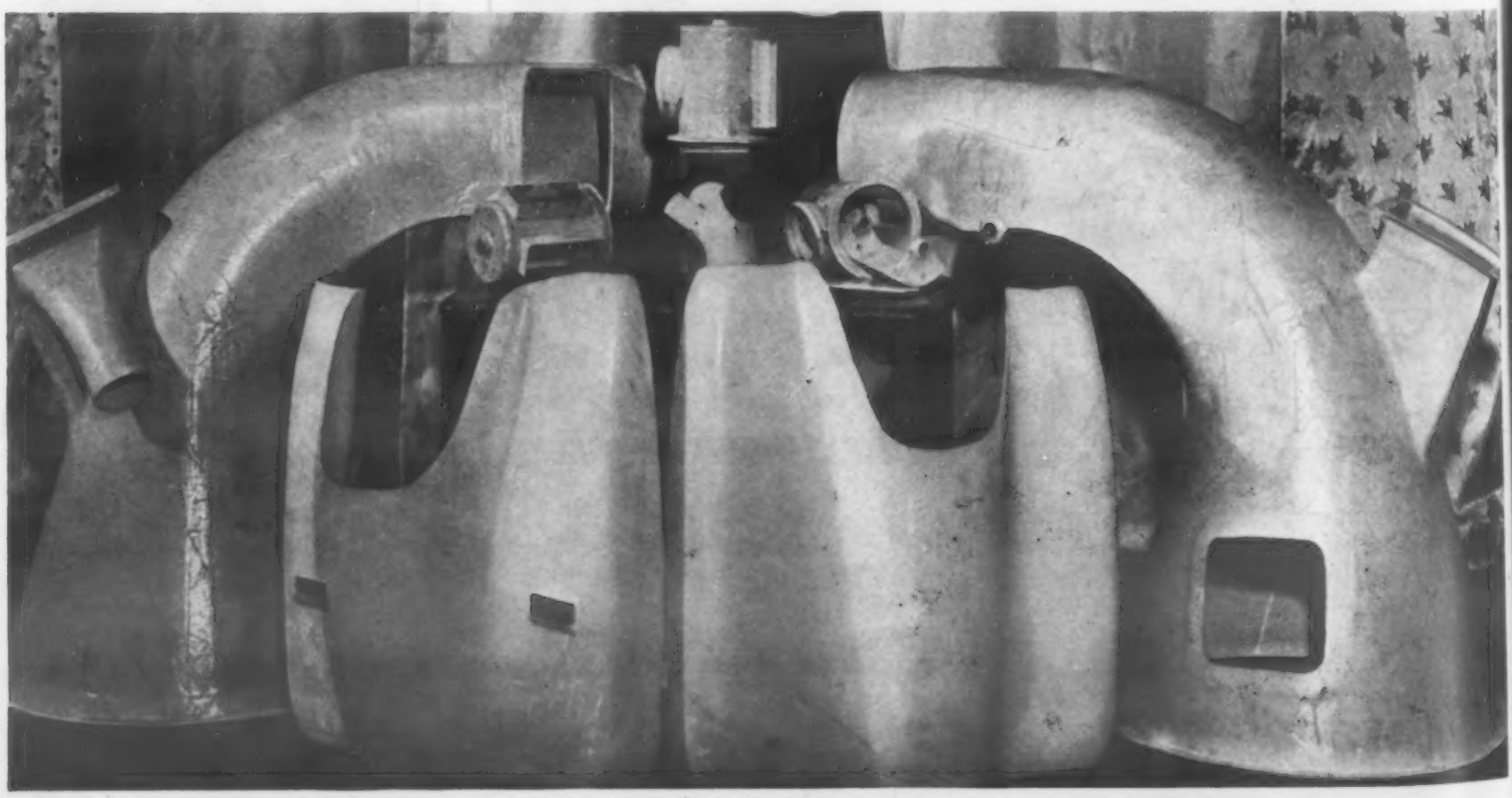
After the binder sets sufficiently to hold the preform together, the shaped piece is removed from the mesh cylinder and taken to an oven where it is baked at 300 F to further set the resinous binder. This is the finished preform. To complete the balance ring, the preform is impregnated with a polyester resin in liquid form. One of the allyl esters is used. The piece is then placed in a press between mating dies, and a pressure of about 45 tons is applied for a few minutes. When polymerization has taken place the finished piece is removed from the press. Colored parts can be made by adding a dye to the liquid resin.

A rather similar laminating process used by several other companies uses chopped fiber for the mat instead of chopped strand. Spartan of Minneapolis is successfully using this material. Both the chopped strand and chopped fiber, as well as the liquid binders, are supplied by Owens-Corning Fiberglas Corp.

The method of making preforms in glass fibers by direct forming of the floc promises to become important through cost savings in the following ways: (1) Several operations can be saved; (2) only simple, inexpensive equipment is needed for preforming; and (3) dimensional and weight specifications can be set closely, and met, because preforming permits close tolerances in the mating dies.

The method is most easily applied to relatively large pieces of rather simple shape, and has wide possibilities there for development. The use of adhesive bonding to join several pieces into a single unit structure may further widen the range of the process by permitting several simple forms to be joined into a more complicated whole.

These fiber glass reinforced plastic aircraft parts illustrate adaptability of the material to fabrication of complex parts. (Courtesy Owens-Corning Fiberglas Corp.)



Materials Engineering File Facts

NUMBER 194
July, 1950

Testing Machines (Tension and/or Compression)
Means of Regulating Testing Speed

Make	Type (Hydraulic or Mechanical)	Speeds Available, In. per Min. (Except Where Otherwise Indicated)		Means of Regulating Speed
		For Tests	To Position Crossheads	
Amsler 20,000-lb. 40,000-lb. 60,000-lb. 100,000-lb. 200,000-lb.	Hydraulic	 0 to 7 0 to 3½ 0 to 5¼ 0 to 5 0 to 4	 Depends on capacity	 Delivery regulator.
Amthor	Mechanical—tension (all materials — maximum 1500-lb. breaking strength)	From 0.0 to 20	From 8 to 20	Step pulley type and variable speed type.
Baldwin-Southwark	Hydraulic—universal Mechanical — universal 5000-lb. capacity	Stepless — varying from 2¼ to 6, depending on capacity. 0 to 20	Varies from 11 to 17, depending on capacity. 20	Radial cylinder pump with pump discharge control crosshead adjustment by motor drive on screws. G.E. Thymotrol.
Detroit	Hydraulic Universal	0 to 1½	5	Gear pump—with pump discharge controls.
Dillon	Model L — universal — mechanical Model M — universal — mechanical	1/16 to 10 0 to 20	5 5	Gear reduction, sprocket and chain, single speed. Graham variable speed drive.
Instron	Mechanical; tension — compression	0.02, 0.05, 0.10, 0.20, 0.50, 1.0, 2.0, 5.0, 10, 12, 20	20 and 2.0	Positional, servomechanism controlled by selsyns from synchronous motor. Chart speeds 0.2 to 50 in. per min., independently selected to secure range of extension magnifications. Load ranges: 2 g. to 1000 (or 5000) lb. full scale.
National Forge	Mechanical — compression (for cartons, etc.)	½ (fixed — ASTM Std.)	6	Two-speed gear shift.
Olsen	Mechanical Hydraulic	Infinite variable 0.025 to 2 Infinite variable 0 to 2	Variable up to 8 Approximately 10	Electronic variable speed control. Hydraulic pump, load valve and automatic regulator valve. Crosshead adjustment by motor drive.
Riehle	Mechanical; tension — compression Hydraulic—compression Hydraulic tension—compression	0.015 to 20 0.05 to 2.5 0.05 to 2.5	Depends on capacity 2.5 12	Combination two-speed gear shift and control knob of Thymotrol unit. Multi-piston pump regulated by control valve. Separate motor-driven crosshead.
Scott	Mechanical for multi-fixed speeds Electrical for variable range	0.2, 0.4, 1, 2, 3, 6, 10, 12, 20 Various in a 20:1 ratio	Lb. per sec. or grains per denier	Mechanical for multi-fixed speeds. Selsyn motor control. Potentiometer end rpm. Tachometer.
Testing Machines, Inc.	Hinde and Dauch	½ to 2 as specified by purchaser	—	—
Thwing-Albert	Electro-hydraulic pendulum, minimum 100 g., maximum 1000 lb. Fixed crosshead, minimum 50 g. maximum 10,000 lb.	Stepless pendulum—2 to 30 Fixed crosshead — 0.02 to 30	— —	Calibrated valve opening. Servo motor positioning valve, controlled by L 50 Sentronic recorder for constant rates of straining and stressing.
Young	Hydraulic—universal Mechanical—universal	0 to 8 0 to 20	1 to 2 ft. per min. 1 to 2 ft. per min.	Rotary pump with suitable control. Crosshead adjustable by motor. Variable voltage and Thymotrol.

NOTE—Mechanical machines up to 5000 lb. are available with testing speeds up to 20 in. per min. For machines 10,000 lb. and above speed to testing up to 3 in. per min. and adjusting speeds up to 10 in. per min. are available.

Compiled by H. L. MacBride, National Forge & Ordnance Co., June, 1949.

From ASTM Bulletin, *No. 161, Oct., 1949.*

Materials Engineering File Facts

NUMBER 195
July, 1950

Corrosion Resistance of Titanium Metal in a Number of Chemical Reagents

Commercially pure titanium is a light, strong, corrosion resistant and ductile metal which promises to become an important engineering material of the future. One of its most attractive properties is its corrosion resistance. In the table below, the corrosion resistance exhibited by titanium to a number of chemical reagents is given.

The letters A, B and C in the last column represent approximate corrosion rates as follows:

A. Titanium probably is completely suitable even though very little dimensional change can be tolerated (corrosion rate less than 0.005 in. per year).

B. Titanium probably is suitable where some corrosion can be tolerated; corrosion equivalent to that of materials now in common use for the application (corrosion rate 0.005 to 0.05 in. per year).

C. Titanium probably is not suitable (corrosion rate greater than 0.05 in. per year).

In general, it can be assumed that when the metal is entitled to a given rating at one temperature, it is entitled to at least as high a rating at all lower temperatures.

(This method of reporting has been patterned after that used in the *Corrosion Handbook*.)

Reagent	Con. (% by Wt.)	Temp., F	Rating
Acetic Acid (Glacial)	99	Boiling	A
Acetic Anhydride	99	Room	A
Ammonium Hydroxide	28	Room	A
Aqua Regia ($3HCl$-$1HNO_3$)	—	Room	A
Aqua Regia ($1HCl$-$3HNO_3$)	—	Room	A
Calcium Chloride	28	Boiling	A
Carbon Tetrachloride (Containing 1% Water)	—	Boiling	A
Chlorine Gas (Water Saturated)	—	167	A
Chlorine Gas (Dry—0.005% H_2O)	—	86	C
Chloroacetic Acid	30	176	A
Chromic Acid	10	Boiling	A
Cupric Chloride	40	Boiling	A
Ferric Chloride	10	Boiling	A
Formaldehyde	37	Boiling	A
Formic Acid	50	Boiling	C
Hydrochloric Acid	1	158	A
	1	Boiling	C
	2	176	A
	3	158	B
	3	Boiling	C
	5	Room	A
	5	158	B
	5	Boiling	C
	10	Room	B
	10	158	C
	20	Room	B
	37	Room	C
Hydrofluoric Acid	1	Room	C
Hydrofluoric Acid (Anhydrous)	100	Room	B
Hydrogen Peroxide	—	Room	C
Lactic Acid	85	Boiling	A
Nitric Acid	65	Boiling	B
	98	Room	A

Reagent	Con. (% by Wt.)	Temp., F	Rating
Phosphoric Acid	10	176	C
	85	Room	B
Sodium Chloride (Saturated Water Solution)	—	Boiling	A
Sodium Hydroxide	10	Boiling	A
	40	176	B
Sodium Hypochlorite (5.6% Cl_2)	—	Room	A
Sodium Sulfide	10	Boiling	A
Stearic Acid	100	356	A
Sulfuric Acid	1	Room	A
	1	Boiling	C
	3	158	C
	5	Room	B
	5	Boiling	C
	10	Room	B
	10	158	C
	40-104*	Room	C
Sulfuric Acid / Nitric Acid Mixture	52 / 48	Room	A
Sulfuric Acid / Nitric Acid / Water Mixture	14 / 83 / 3	Room	A
Sulfur (Molten)	100	464	—
Sulfur (Water Suspended)	—	Room	A
Trichlorethylene (Unstabilized—Containing 1% Water)	—	Boiling	A
Trichlorethylene (Stabilized—Containing 1% Water)	—	Boiling	A
Water (Chlorine Saturated)	—	167	A
Water (Hydrogen Sulfide Saturated)	—	Room	A
Water (Sulfur Dioxide Saturated)	—	Room	A
Zinc	10	Boiling	A

**Fuming sulfuric acid containing SO_3*

Courtesy Remington Arms Co., Inc.

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because it's

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When you want customers to look *at*—or look *through*—your product, specify PLEXIGLAS molding powder. This acrylic material makes clear or colored decorative pieces gleam like jewels. And in lenses, transparent sections, housings, true optical clarity is assured.

The excellent flow characteristics of PLEXIGLAS powders permit satisfactory molding over a wide range of temperatures and pressures. We offer 3 different injection grades, each developed to meet specific requirements—PLEXIGLAS V, VM and VS.

16-inch picture tube lens injection molded of PLEXIGLAS VM by Erie Resistor Corporation, Erie, Pa., for Sylvania television sets. PLEXIGLAS acrylic plastic lenses have perfect, water-white clarity ... plus strength that passes Underwriters' Laboratories tests for *all* lens sizes, and results in superior resistance to damage both in shipment and in the home.

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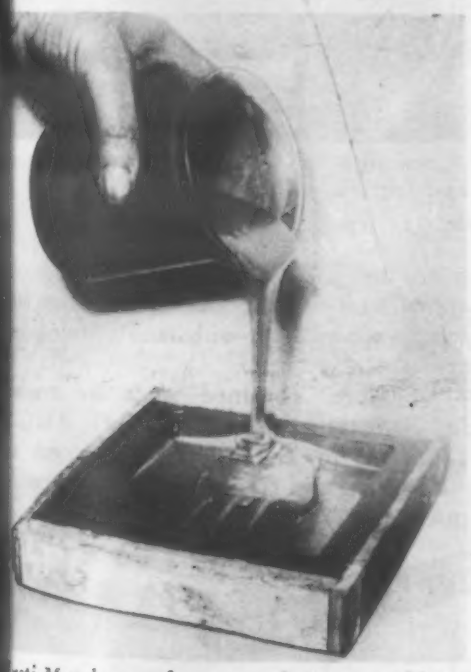
New Materials and Equipment

Materials

stic-Metal Casting Compound

A new casting compound which is ither plastic nor metal, yet has charac-istics of both, has been developed by *Plastics Div.* of *The Lockrey Co.*, Col-e Point, N. Y. The thermosetting mate-l is said to be completely resistant to all mmon chemicals except strong alkalis.

Although Plasti-Metl is the color of pper and harder than some casting metals,



sti-Metal can be poured into molds at room temperature.

can be poured into molds at room tem-rature. With the aid of varying amounts catalyst, it can be made to set at room mperature without heat, or in an oven low temperatures, forming a tough cast-g that can be machined or polished with linary tools.

Plasti-Metl can be poured into rubber, stomer, plastic, metal or clay molds, with without inserts, or it can be slush-molded. It is expected to be useful for forming molds, novelties, machine-replacement parts, etc.

Technical Ceramic

A ceramic material having unusual thermal expansion characteristics has been developed by *Stupakoff Ceramic & Manufacturing Co.*, Latrobe, Pa. Named Stupalith, the material can be formulated and processed to possess zero thermal expansion, retraceable low positive thermal expansion equivalent to fused silica, or retraceable low thermal contraction.

Stupalith compositions are basically lithium alumino silicates. They are formed by conventional methods of pressing, extrusion and casting and, where necessary, by subsequent machining or grinding operations.

Extruded forms have been subjected to gas blasts at elevated temperatures and cooled at the rate of 90 F per sec. with no failures in more than 60 cycles. Pressed specimens have been subjected to a continuous temperature of 2000 F for periods up to 120 days with no change in specific gravity. Pressed and extruded specimens have also survived 100 cycles of thermal shock induced by quenching in liquid air from 2000 F.

Principal properties can be summarized as follows: limiting temperature of use, 2200 F; linear coefficient of thermal expansion, from -1.5×10^{-6} to $+1.5 \times 10^{-6}$; water absorption, 0 to 18% as desired; specific gravity, 2.1 to 2.4; density, 0.076 to 0.086 lb. per cu. in.; dimensional tolerances, $\pm 2\%$; dielectric strength, 140 v. per mil.; dielectric constant (1 megacycle), 7.82; power factor (1 megacycle), 0.0048; and loss factor (1 megacycle), 0.0520. Stupalith is unaffected by halogens and acids, except hydrofluoric and phosphoric acids. In appearance, the material is white-to-buff colored, smooth, vitreous and non-devitrifying.

Stupalith is suitable for use in electrical and radio circuits. In addition, it is being evaluated by the Air Materiel Command for use in radomes and jet- and rocket-engine parts.

CONTENTS

Plastic-Rubber Material

A thermosetting plastic-rubber blend expected to replace hard rubber in many industrial applications has been developed by *U. S. Rubber Co.*, 1230 Avenue of the Americas, New York 20. (A feature article on this material appeared in MATERIALS & METHODS, June 1950, p. 67.)

The high-strength light-weight material, called Enrup, is also resistant to abrasion and chemical attack. It is being produced

New Materials and Equipment
(CONTINUED)

in four standard grades ranging from 2000 to 4400 psi. in room temperature tensile strength, 65 to 80 Durometer "D" hardness

This truck distributor cap is molded from Enrup.

and 45,000 to 236,000 psi. in modulus of elasticity.

Available forms are sheet, rods, tubes, gear blanks and molded parts.

Phenolic Molding Compounds

Three new phenolic molding compounds have recently been marketed by *Durez Plastics & Chemicals, Inc.*, North Tonawanda, N. Y. These impact type compounds are: Durez 13537 Natural and Durez 14482 Black, both high-impact, fabric-filled materials; and Durez 14658 Black, a nitrile rubber-bearing, wood-flour-filled material.

Durez 13537 Natural has an Izod impact strength of 1.4 ft.-lb. per in. Good mechanical and electrical properties are claimed for this material which, because of good flow properties, can be either compression or plunger molded.

Durez 14482 Black is similar to 13537 but has an impact strength value almost 60% greater (2.2 ft.-lb. per in.). Molding properties are not appreciably affected.

Durez 14658 Black has the moldability of general-purpose materials but, because of its nitrile rubber content, it has improved impact strength and shock resistance. Its low modulus of elasticity (0.6 x 10^6 psi.) allows it to be used in thin sections around metal inserts. The material can be plunger or compression molded and has good surface appearance.

Stainless Steel Powders

Two grades of stainless steel powd for metal powder parts are now availa from *American Electro Metal Corp.*, Yonkers Ave., Yonkers, N. Y.

Grade 140 is essentially 14% chromi balance iron; Grade 188 is a 17 to chromium, 8 to 9% nickel composit Both powders are claimed to have g green strength and moldability. (Furt information on these new stainless powd can be found in the feature article on p 52 of this issue of MATERIALS & METHOD

Chromium-Plated Steel Rod

Chromium-plated steel rod is now av able from *Kenmore Metals Corp.*, Ninth St., Jersey City 2, N. J. The bri corrosion resistant finish is said to be u damaged by bending, forming, spot we ing, butt welding or swaging.

These rods are produced by a two-s electroplating process. Nickel is first bond to a steel rod; then chromium is pla

Kenmore "chromed" rod has corro resistance approaching that of stainless b is easier to fabricate.

over the nickel. The nickel underpl contributes to the ductility of the fini which allows it to withstand forming op ations.

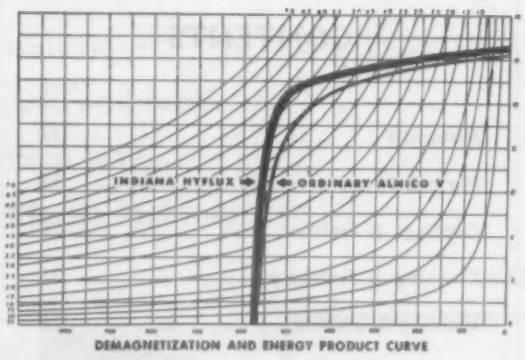
Kenmore "chromed" rods are availab in diameters ranging from 11 AWG t 5/16 in. in any commercial length a with nickel and chromium plates of specif thicknesses.

Parts & Forms

Permanent Magnets

Permanent magnets with a guaranteed energy product of at least 5¼ million BHmax are being distributed by the *Indiana Steel Products Co.*, Valparaiso, Ind. This is claimed to be 16% greater than the highest published guaranteed energy product for regular Alnico V.

Called Hyflux Alnico V, the new magnet is expected to accomplish extremes in compact design not heretofore possible. The magnet does not represent a new alloy, but rather the result of a new production technique applied to Alnico V.



More compact design is predicted as a result of Indiana Steel's improved permanent magnet.

Coatings & Finishes

Primer

A new primer for iron and steel, claim to eliminate the need for chromic a treatment, is being marketed by *Kel*

New Materials and Equipment

Products, Inc., Box 2917, Terminal Anne Los Angeles 54.

Called Poly-Kote, it forms a dense smoo film of low porosity and high plastici which cannot absorb paint excessively. T uniform, fine-textured crystalline coati can be controlled to provide a light heavy paint-bonding film. This coating said to have good resistance to salt spr on both painted and unpainted work.

Poly-Kote is non-toxic and non-infla mable. Immersion or spray applicati can be used and no expensive equipme is required.

Coating Resins

Two urea formaldehyde coating resi designated as Uformites F-210 and F-23 have been introduced by *Resinous Produc Div.*, of *Rohm & Haas Co.*, 224 W. Was ington Sq., Philadelphia 5, Pa.

Uformite F-210 is said to provide hig viscosity and wide compatibility, in ad tion to good gloss and fast curing chara teristics. Its retention of high viscosity whe diluted leads to economical coatings of lo solids content. It can be used with lar quantities of mineral thinner and has hig water resistance when used in a typic baked enamel of the alkyd type. Its ad hesion in one-coat enamels is claimed to b good, even when used with large concentr tions of non-oxidizing alkyds. This ne resin has been suggested for use in finish for household appliances, kitchen cabine and hospital and surgical equipment.

Uformite F-233 is said to permit prepara tion of fast-baking industrial coatings wi high proportions of inexpensive aliphat solvents. It combines compatibility wit highly-polymerized as well as long-oil a kyds, high tolerance for mineral thinner and fast baking speed. Its compatibili with alkyds prevents "kick-outs" and help produce glossy coatings.

One-Coat Enamel

A one-coat synthetic enamel for conveyo dip application on odd-shaped metal part has been developed by *United Lacquer Manufacturing Corp.*, Linden, N. J.

Base 38862 breaks at vital points an adheres well to various types of metal It is said to cover evenly all surfaces o odd-shaped items in a single dip operation Since enameling such odd-shaped piece normally has required more than one opera tion, use of this new coating is expecte

ANNOUNCING A NEW CONTACT TYPE ELECTRODE SPECIALLY DESIGNED FOR LIGHTER GAUGES!

EUTECTIC WELDING ALLOYS

HAND-O-MATIC*

FOR BETTER, SAFER, FASTER, MORE ECONOMICAL MASS PRODUCTION WELDING

*Reg. T. M.

Super-Fast • No Arc-Gap "Anti-Fatigue" Electrode for Hand-operated, Automatic Welding of Steel

ousands and thousands of pounds of this amaz-ly faster "contact-type" electrode are already inging enormous new savings to welders of hter gauge steels from coast to coast. Now YOU n enjoy these same "plus" benefits in your pro-ction welding: • More weld in less time • Elimi-te burn-through on thin sheet • Less expensive ality control • Lower cost per foot of welded joint • Less operator fatigue • Higher production rate per unit time. Simply speaking—this new HAND-OMATIC electrode makes it possible to weld faster and use less welding electrode than conventional electrodes because of a new type coating that results in an extremely fine spray-type metal transfer through the electric arc!

By slightly increasing the welding current, you can run HAND-OMATIC *three to four times faster* than conventional electrodes on many, many applications where high speed welding is advantageous. On most types of steel sheet fabricating this results in enormous savings in time and labor.

Because of the extreme smoothness and regularity of the hand-operated, automatic weld you get with HAND-OMATIC, you can drastically cut down the consumption of electrode per foot of weld. Reduction of electrode consumption by 50% is quite common—and that's *real* economy!

The cleanliness, the regularity, the flatness, the definitely *better appearance* of the beads you obtain with HAND-OMATIC make finishing unnecessary in the greater majority of cases. Where you *do* want to finish the welded joint, there is very little work since your HAND-OMATIC welds feather out in a surprisingly easy manner and drastically reduce cost of finishing. *That's a highly important economy factor!*

The high speed at which HAND-OMATIC is applied results in close control of distortion and warping . . . greatly lessens the amount of straightening required by conventional electrodes. The flatness and smoothness of the HAND-OMATIC beads diminish the amount of tension and stress normally caused by the heavy round beads of conventional type electrodes. *This advantage not only cuts costs but speeds finished production as well!*

HOW IT WORKS

HAND-OMATIC requires *no special equipment, no special gases, works with BOTH AC and DC.* Simply insert into any ordinary electrode holder, hold diagonally against the metal, and drag straight along, like a pencil! No back-and-forth weaving motion is needed. The electrode is *constantly held right against the metal.* NO ARC DISTANCE IS NECESSARY. The problem of keeping the correct arc distance is completely eliminated—along with the tedious fatigue that conventional arc electrodes cause. In short, now ANY *torch welder* can arc weld steel with this new HAND-OMATIC electrode!

Send for FREE illustrated leaflet, technical data, etc. No obligation!

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Eutectic Welding Alloys Corp., 40 Worth St., N. Y. 13

RUSH—without cost or obligation send me FREE folder describing further information on the new savings I can enjoy by using "contact-type" electrodes in my production.

Name_____

Address_____ Zone_____

City_____ State_____

New Materials and Equipment

to yield savings in production time a unit costs.

The enamel can be baked in a gas o or under infra-red lamps. It is available all colors in gloss, satin or dull finish.

Heating-Element Paint

A paint which serves as a heating e ment has been developed by *Electrof Corp.*, 7116 Laurel Canyon Blvd., No Hollywood, Calif. The paint, which sprayed on the part and protected w insulating varnish, can be supplied in w

These aircraft hydraulic cylinders ar typical application for Electrofilm's heati element paint.

densities up to 250 watts per sq. in. a withstands temperatures up to 400 F.

The paint element, weighing 0.1 lb. p sq. ft., is being used for hydraulic cylinder relief tubes, ammunition boxes, air intak scoops, cameras, forming dies, etc.

Coating for Brass

An anti-corrosive clear baking finish fo brass and brass products has been developed by *Standard Varnish Works*, 2587 Richmond Terrace, Staten Island, N. Y. Named No. 7318 Clear Baking Finish, the new coating is recommended wherever brass or brass plating is used, as in builders' hardware, cosmetic cases, lighting fixtures, marine fittings and luggage hardware.

Fast-Drying Enamel

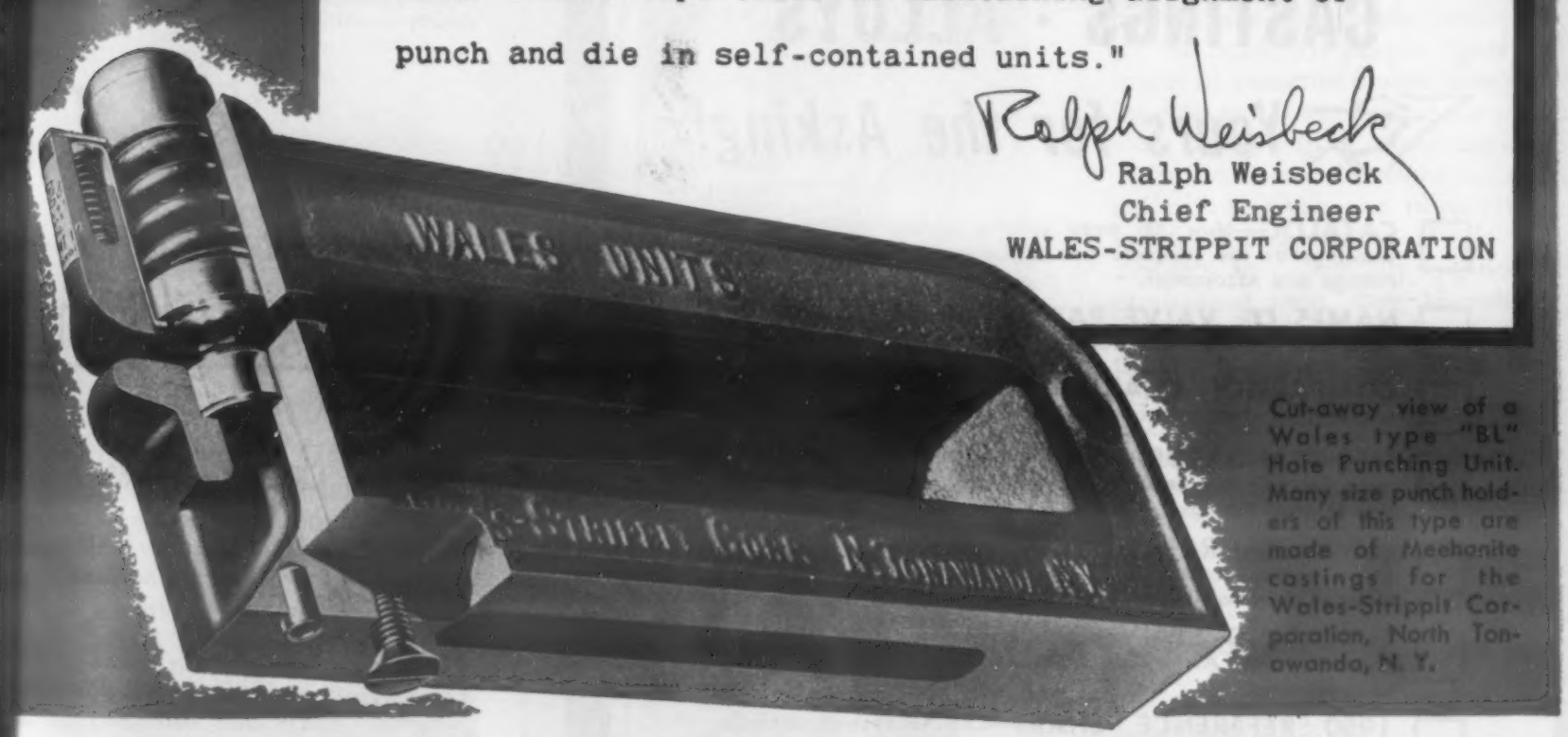
A synthetic protective coating which provides the hardness of a baked-on synthetic, but air-dries as fast as lacquer, has been announced by *United Lacquer Manufacturing Corp.*, 1001 W. Elizabeth Ave., Linden, N. J.

A Chief Engineer speaks... about MEEHANITE® Castings

"Meehanite castings provide the combination of qualities that definitely contributes to the successful manufacture and function of our sheetmetal perforating units. Their ability to take a smooth finish and their wear resisting properties greatly increases the life of the units. The freedom from warpage or movement after machining found in Meehanite castings is of utmost importance in maintaining alignment of punch and die in self-contained units."

Ralph Weisbeck

Ralph Weisbeck
Chief Engineer
WALES-STRIPPIT CORPORATION



Cut-away view of a Wales type "BL" Hole Punching Unit. Many size punch holders of this type are made of Meehanite castings for the Wales-Strippit Corporation, North Tonawanda, N. Y.

The above statements express the importance of dependability and quality to those who carefully select and specify required engineering characteristics for their components. In the manufacture of Meehanite castings control of metal structure permits achievement of desired properties. When you insist upon Meehanite castings you are insuring just such benefits and economies plus built-in quality of your equipment.

For details covering a wide range of general industrial applications write for our four volume series "Meehanite Means Better Castings."

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American Brake Shoe Co. ..... Mahwah, New Jersey
The American Laundry Mach. Co. .... Rochester, N. Y.
Atlas Foundry Co. ..... Detroit, Michigan
Banner Iron Works ..... St. Louis, Missouri
Barnett Foundry & Machine Co. ..... Irvington, N. J.
E. W. Bliss Co. ..... Hastings, Mich. & Toledo, O.
Builders Iron Foundry Inc. ..... Providence, R. I.
Continental Gin Co. ..... Birmingham, Alabama
Cooper-Bessemer Corp. Mt. Vernon, O. & Grove City, Pa.
Farrel-Birmingham Co., Inc. ..... Ansonia, Conn.
Florence Pipe Foundry & Mach. Co. .... Florence, N. J.
Fulton Foundry & Machine Co., Inc. ..... Cleveland, O.
General Foundry & Mfg. Co. ..... Flint, Michigan
Greenlee Foundry Co. ..... Chicago, Illinois
Hamilton Foundry & Machine Co. .... Hamilton, O.
Johnstone Foundries, Inc. ..... Grove City, Pa.
Kanawha Mfg. Co. ..... Charleston, West Virginia
Koehring Co. ..... Milwaukee, Wisconsin
Lincoln Foundry Corp. ..... Los Angeles, California
E. Long Ltd. ..... Orillia, Ontario
Otis Elevator Co., Ltd. ..... Hamilton, Ontario
The Henry Perkins Co. ..... Bridgewater, Mass.
Pohiman Foundry Co., Inc. ..... Buffalo, New York
The Prescott Co. ..... Menominee, Michigan
Rosedale Foundry & Machine Co. ..... Pittsburgh, Pa.
Ross-Meehan Foundries ..... Chattanooga, Tenn.
Shenango-Penn Mold Co. ..... Dover, Ohio
Sonith Industries, Inc. ..... Indianapolis, Ind.
Standard Foundry Co. ..... Worcester, Mass.
The Stearns-Roger Mfg. Co. ..... Denver, Colorado
Traylor Engineering & Mfg. Co. ..... Allentown, Pa.
Valley Iron Works, Inc. ..... St. Paul, Minnesota
Vulcan Foundry Co. ..... Oakland, California
Warren Foundry & Pipe Corp. Phillipsburg, N. J.

"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.

New Materials and Equipment

The finish, labeled Base Y 2054, was developed particularly for plants which do not have baking facilities, although its flexible hard surface is expected to make it useful also to fabricators who do have their own baking facilities. Products finished with this synthetic can be handled and stacked within 15 min. and packed in 3 or 4 hr.

The new finish is claimed to offer a higher build, a better gloss where desired, tougher film, and high resistance to alkalis, fats, grease and smoke. It is equally effective on wood, metal or fiber products. It can be polished to a hard gloss and has good gloss and color retention, even under high humidity conditions.

Cleaning & Finishing

Immersion Cleaner for Steel

An immersion cleaning compound developed specifically for immersion cleaning of steel parts prior to vitreous enameling has been announced by *Detrex Corp.*, Box 501, Detroit 32.

Known as Detrex 70, the alkaline cleaner is said to have high wetting and penetrating properties, exceptional detergency on all types of soil, ability to emulsify large quantities of oil and prevent "carry-over" into subsequent stages of the process, and free rinsing qualities. It is non-sludge forming, being completely soluble in hot water even at high concentrations, and it can be boiled continuously in solution without breaking down. It is also said to hold its strength in solution, thereby reducing "make-up" requirements.

Concentration make-up is 6 to 8 oz. per gal. at temperatures of 200 F to boiling. It is available in either 140-lb. steel kegs or 500-lb. steel drums.

Buffing Machine

A sheet buffing machine for finishing of ferrous and nonferrous metals has been announced by *Hill Acme Co.*, 6400 Breakwater Ave., Cleveland.

The new machine is called the Openside Oscillating Type Sheet Buffing Machine. It has a hydraulic table and power elevating

It pays to use your custom molder's know-how

...when you want something to look better and cost less

PROJECT
Snap-locking carafe handle

CUSTOMER
Sparkletts Drinking Water Corporation
Los Angeles

MOLDER
F. E. Reinhold, Mfr., Los Angeles

MATERIAL
Durez general-purpose phenolic plastic

● Californians who refresh themselves with Sparkletts spring water voiced no complaint about the old metal and rubber rack-type carafe handle. Even so, the Sparkletts people figured there might be a smarter design, new product interest, and lower cost, if the problem were attacked from a new angle.

An experienced custom molder was called in, given the objectives, and asked for suggestions. While custom molders are essentially engineers and production men, their knowledge of plastics properties is always useful in matters of design. Sparkletts found it extremely so.

Using the freedom of design permitted by plastics, the molder conceived and produced a two-piece holder of strong, lustrous Durez that has won many compliments and much new business for the bottling firm.

Success from the cost angle was spectacular too . . . the Durez pouring holder costs only half as much as the metal one it replaced. The old holder required twenty rivets and a rubber handle cover. On the new one, the assembling screw and socket and the tapered grip are molded in. The self-locking plunger latch allows the holder to revolve freely around the bottle neck.

Whether or not you have a full-scale design department, your custom molder can take a constructive part in your new or revised product planning. Let him help you profit from the versatile properties of Durez and other plastics. Durez phenolics specialists are also available for free consultation.

A hit with plastics users everywhere is the handy "Durez Check-Chart." Write for yours. Durez Plastics & Chemicals, Inc., 147 Walck Rd., N. Tonawanda, N. Y.

DUREZ

PHENOLIC RESINS

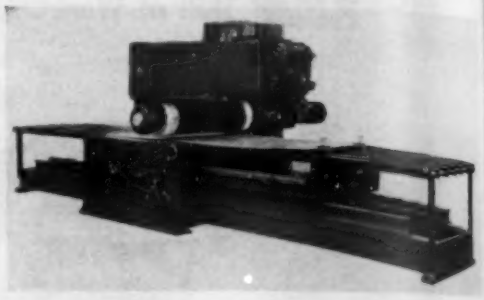
- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- PROTECTIVE COATING RESINS

PHENOLIC PLASTICS THAT FIT THE JOB

New Materials and Equipment

and lowering head for 18-in. dia. buff roll or Tampico brush roll.

The oscillating mechanism is powered by a 3-hp. motor and has a stroke variation



The Acme Hill buffing machine is built for heavy-duty finishing of metals.

from ½ to 2 in., and a range of 50 to 150 cycles per min. The main spindle is powered by a 50- to 100-hp. main drive motor. The machine is built in table widths up to 72 in. and table lengths of 8 ft. and over.

Metal Degreaser

A metal degreaser which is used cold is being marketed by *Barco Chemical Products Co.*, 701 S. LaSalle St., Chicago 5. Claimed to remove all oil, grease, waxes, etc., Barco Metal Degreaser Q 200 is also suitable for plastics, wood and glass.

●

Welding & Joining

Mild Steel Electrode

A mild steel electrode, called "Fleetweld 72," has been announced by *Lincoln Electric Co.*, 13012 Coit Rd., Cleveland 1. The E6012 electrode is claimed to make possible high-speed production of single pass fillet and lap welds in the flat position.

The new electrode operates best at currents above those normally used with E6012 electrodes, and does not overheat. The higher melt-off rate enables greater welding speeds, and the arc characteristics produce good root penetration. The nearly flat bead is in contrast to the excess weld metal usually encountered with E6012 electrodes, and affords greater weld length deposited per electrode.

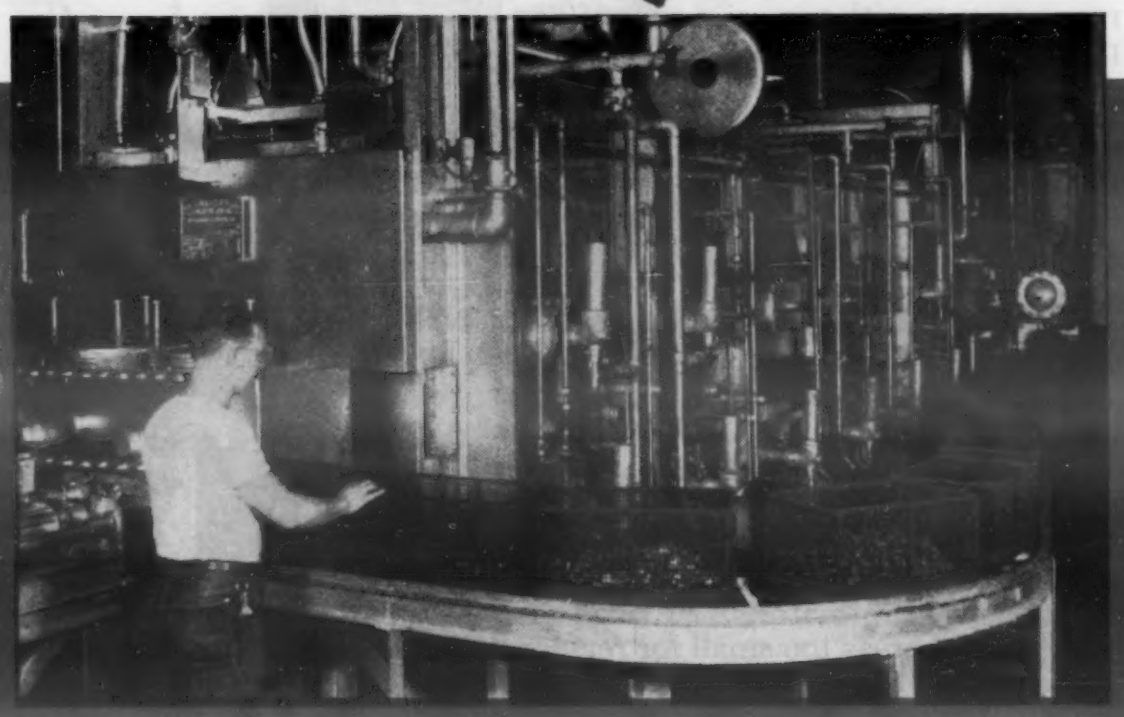
Operating current range of the electrode is broader than that of conventional E6012 electrodes, and the type of arc is especially

ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

GAS CARBURIZING BASKETS

10 to 12 Months Life,
3 Shift Service



The Rolock fabricated baskets shown have handled with outstanding economies drive shaft parts through a Surface Combustion Continuous Gas Carburizing furnace in the plant of a large automotive manufacturer in Detroit. Repeated exposure to the embrittling, high temperature environment has proven these baskets.

A recent performance check conclusively demonstrates the advantages of fabricated construction for service of this nature.

1. *The baskets have a life of 10 to 12 months of 3-shift service in this embrittling atmosphere.*
2. *100 lb. live loads handled with ease in this 31 lb. basket...2¼ to 1 work/alloy ratio, tray included!*
3. *Design assures thorough atmosphere circulation as well as quench oil circulation and complete drainage.*
4. *Uniform, high quality work attained from part to part, and load to load.*

Rolock fabricated heat treating equipment is cutting costs in leading plants through engineered-to-the-job construction which produces prolonged service life, increased furnace capacities with reduced dead weight, and improved product quality.

Call a Rolock engineer for our recommendations on reducing your heat-hour costs.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • INDIANAPOLIS • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS

ROLOCK INC. • 1282 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

7RLSO

New Materials and Equipment

suited for working where fit-up is poor. It also is suited to making lap welds in which the weld feathers smoothly into the top edge of the joint.

The "Fleetweld 72" is available at standard prices in 14- and 18-in. lengths and in a range of diameters from ⅛ to 5/16 in. for operation on both a.c. and d.c.

No-Gap Steel Electrode

A new electrode, "Eutec-Hand-Omatic," said to speed up production and lower costs, has been introduced by *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13. It is claimed to eliminate welder fatigue and the danger of burning through light-gage materials.

The a.c.-d.c. electrode is pressed against the metal and drawn straight along, like a

Eutec-Hand-Omatic is used to weld mild steels and low-alloy, high-tensile steels.

pencil, without any back and forth or weaving motion. Lack of an arc gap simplifies operation and makes possible a smooth, flat bead.

The electrode has 70,000 to 80,000 psi. tensile strength. It is available in 3/32-, 1/8- and 5/32-in. dia. for all-position welding and in 1/8- and 5/32-in. dia. for flat and horizontal fillets or for underwater use.

Silicone-Insulated Welder

A compact, silicone-insulated a.c. welder, known as the 6WK20H series, has been announced by the *Welding Divisions* of *General Electric's Apparatus Dept.*, Schenectady 5, N. Y. The silicone insulation, water-repellent and unaffected by high temperatures, is said to provide a high margin of safety and operating dependability.

The portable welder has a current range

Mold Making

Pattern Making

Planning

STEP-BY-STEP

Pouring

X-ray Inspection

Final Check

ECLIPSE-PIONEER *Foundries*

LEAD THE WAY TO BETTER CASTINGS

It is only natural that castings from the Eclipse-Pioneer Division Foundries are *better,* because every step in their manufacture is carried out by skilled craftsmen—each man an expert in his field and each field backed by more than 20 years experience. In addition to using the most modern machines, techniques and testing devices obtainable, the entire production line is conveyorized to assure rapid and economical service on all orders. If you plan to use aluminum and magnesium castings in your product, make it a point to consult Eclipse-Pioneer. Meanwhile, send for Eclipse-Pioneer's "Book of Facts."

ALL
Aluminum and Magnesium Alloys
Including the recently developed
Cerium and Zirconium Magnesium Alloys

PLEASE SEND ME THE ECLIPSE-PIONEER "*BOOK OF FACTS*" ON MAGNESIUM, ALUMINUM AND BRONZE CASTINGS.

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COMPANY _____ STREET _____

CITY _____ ZONE _____ STATE _____

MAT

AND PRECISION (±.005")

PLASTER MOLD CASTINGS

ECLIPSE-PIONEER DIVISION FOUNDRIES
BENDIX AVIATION CORPORATION
TETERBORO, N. J.

Bendix AVIATION CORPORATION

New Materials and Equipment

from 30 to 250 amp. and accommodates electrodes from 1/16- to 3/16-in. dia. It measures 12 by 17 in. in cross section and 23 in. in height. Weight is 154 lb.

A "Hot Start" automatic control provides instant arc striking without any manual adjustment. The ampere range is

Coil insulation for this new G.E. welder is impregnated with high temperature resisting resins known as silicones.

covered by three overlapping current ranges which permit precise current control. With automatic control and overlapping current ranges, lower operating costs are assured because idling current is reduced to a minimum and more efficient use of electric power is made.

●

Forming

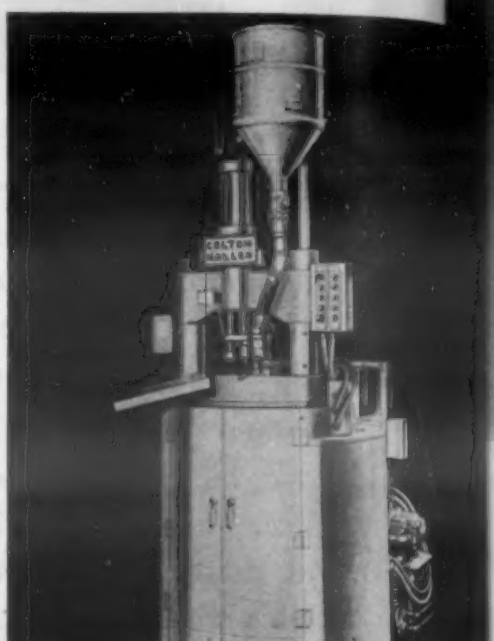
Powdered Metal Presses

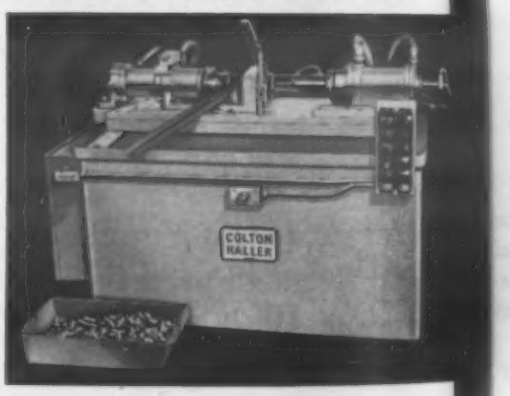
Powdered metal presses are to be marketed by the *Arthur Colton Div. of Snyder Tool & Engineering Co.*, 3400 E. Lafayette, Detroit 7. These presses will incorporate the patents, designs and process techniques developed by *Michigan Powdered Metal Products Co.*

The new Colton-Haller presses will be made in the following capacities: 25-ton with 5-in. fill, 40-ton with 8-in. fill, 100-

New Materials and Equipment

ton with 9-in. fill, and 125-ton with 9- fill. The 25-ton model is a two-tie press; the others are four-tie rod pres Fills are adjustable from zero to the m chine capacity, and filling is done by reciprocating shoe mechanism for powder metal work. A shuttle feed is available





Shown above are the Colton-Haller 25-t powdered metal press (top) and the si sizing press (bottom).

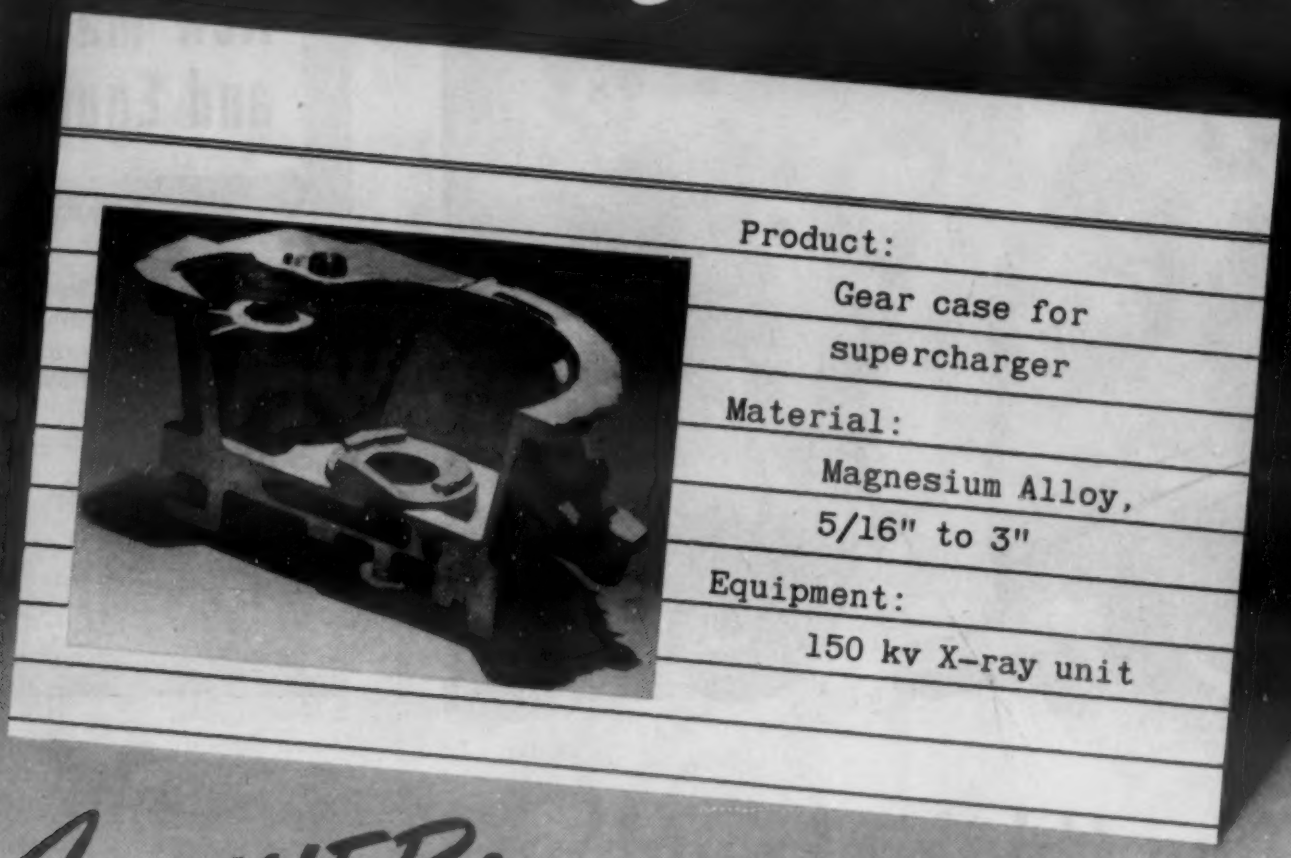
plastic preform work. All machines a designed for rapid approach speeds a slow pressing speeds, and a wide variety motions are available.

The Colton-Haller line will also includ a horizontal hydraulically-operated sizin press for bringing powdered metal par back to size after they have been he treated.

Injection Molding Machine

An increase in molding capacity is no featured on the improved Model 10J-60-o injection molding machine produced b

What's the right X-Ray film?

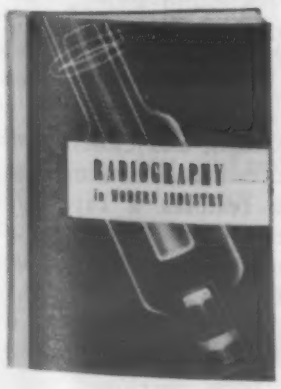


ANSWER:

KODAK INDUSTRIAL X-RAY FILM, TYPE M

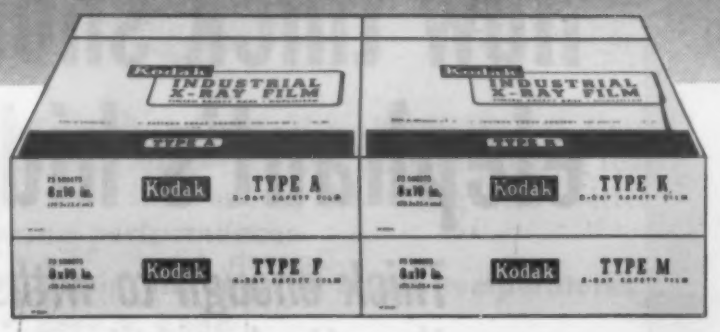
The purpose here was to check not alone for discontinuities but for the thickness of the walls of internal oil passages. Radiographic quality was important—equipment capacity was adequate and length of exposure was no problem. So the Radiographer selected Kodak Industrial X-ray Film, Type M.

Type M Film provides extremely high contrast and extra-fine grain. It is the right film for radiography of the light metals at moderate kilovoltages.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get your copy from your local x-ray dealer—price, $3.



A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check castings and welds efficiently and thus extend the use of both processes.

Type A—has high contrast with time-saving speed for study of light alloys at low voltage and for examining heavy parts at 1000kv. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, under direct exposure or with lead-foil screens. It has extra-fine grain and, though speed is less than in Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays, exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

EASTMAN KODAK COMPANY
X-ray Division • Rochester 4, N. Y.

Radiography...

another important function of photography

Kodak
TRADE-MARK

New Materials and Equipment

Reed-Prentice Corp., Dept. P, Worcester 4, Mass. The mold opening, formerly only 24 in., has been increased to 36 in. and the casting area has been increased from 210 to 350 sq. in.

A newly-designed timing panel automatically controls die plate and plunger. Push buttons control mold adjustment and heating cylinder adjustment, but manual operation is instantly obtainable at any time. The large-capacity heating cylinder assures rapid plasticizing of 250 lb. per hr.

Shown here is part of the Reed-Prentice improved 10J-60-oz. injection molding machine.

●

Testing & Control

Abrasion Resistance Tester

A new device for testing the abrasion resistance of solid materials and coated surfaces has been announced by *Taber Instrument Corp.*, 109 Goundry St., North Tonawanda, N. Y.

The Taber Abraser, Model 140, incorporates the rotary rub-wear action of dual abrading wheels crisscrossing their abrasion path. One wheel rubs the specimen from center outward and the other rubs the specimen from the outside in toward the center so that the abrasion lines cross each other like the letter "X". This action is continuous throughout the 360-deg. rotation of the specimen, and closely parallels abrasive wear encountered in actual use.

The machine features a capacitor-type motor with heavy-duty worm-gear drive, powerful vacuum unit with dual suction nozzle for picking up abradings, and electric counter for registering the wear cycles. A variety of holders for different kinds of specimens have been developed, and different kinds of abrading wheels can be selected to correspond as closely as possible to the type of service to which the specimen will be subjected in actual service.

A "wear factor" can be calculated repre-

New Materials and Equipment

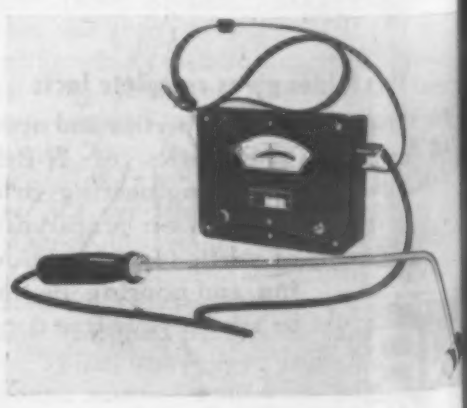
senting the loss in weight per 1000 cyc under a specified set of test conditio Or, quantitative or total wear of a specim surface can be indicated by the counter the first sign of penetration, like a sp worn off a paint coating or a hole appear in a fabric. Both methods give a numeric

The Taber Abraser can be used to test soft materials or coated surfaces.

result which is directly comparable fo different samples. Where a decorative pa tern is embossed or applied underneath protective coating, the test is usually ru to the end point where the appearan becomes objectionable.

Solder Analysis

A portable, direct-reading indicator fo the determination of the ratio of lead an tin content in solder has been announced b *Wheelco Instruments Co.*, 847 W. Harriso St., Chicago 7, Ill. It makes possible rap

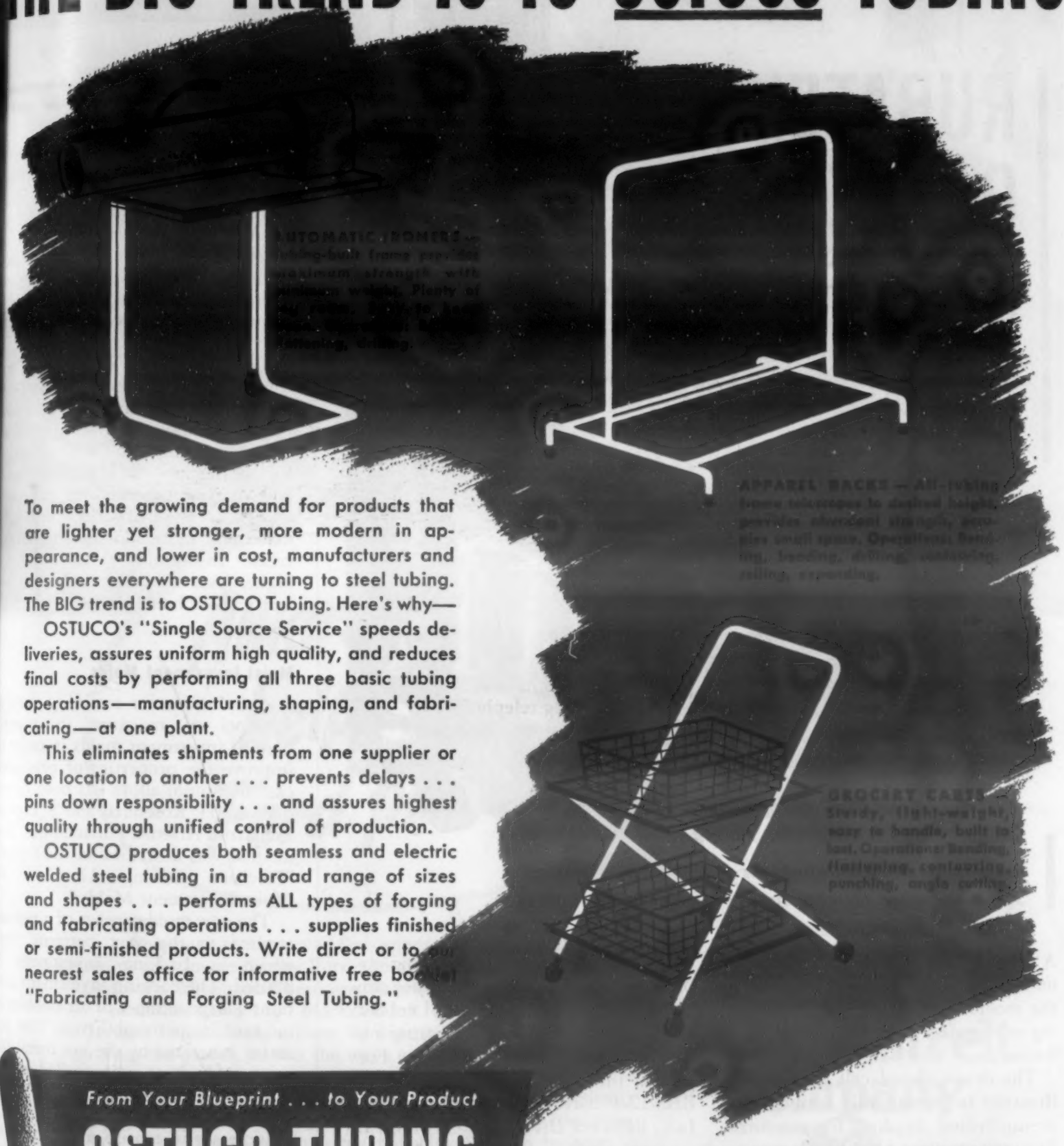


Shown above is the Wheelco Portable Te Content Indicator meter with shoulder stra and lightweight sensing unit.

analysis of lead alloys containing up to 7 tin.

Its use is expected to eliminate tim consuming laboratory tests, resulting in sa ings and improved product quality.

THE BIG TREND IS TO OSTUCO TUBING



To meet the growing demand for products that are lighter yet stronger, more modern in appearance, and lower in cost, manufacturers and designers everywhere are turning to steel tubing. The BIG trend is to OSTUCO Tubing. Here's why—

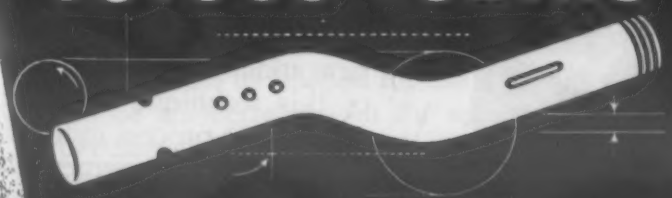
OSTUCO's "Single Source Service" speeds deliveries, assures uniform high quality, and reduces final costs by performing all three basic tubing operations—manufacturing, shaping, and fabricating—at one plant.

This eliminates shipments from one supplier or one location to another . . . prevents delays . . . pins down responsibility . . . and assures highest quality through unified control of production.

OSTUCO produces both seamless and electric welded steel tubing in a broad range of sizes and shapes . . . performs ALL types of forging and fabricating operations . . . supplies finished or semi-finished products. Write direct or to our nearest sales office for informative free booklet "Fabricating and Forging Steel Tubing."

From Your Blueprint . . . to Your Product

OSTUCO TUBING



Tapering • Swaging • Flanging • Bending
Upsetting • Expanding • Reducing • Beading
End closing • Spinning • Drilling • Slotting
Notching • Flattening • Shaping • Trimming
Threading • Angle Cutting • And Many Others

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AFS Papers . . .

continued from page

9600 cycles and seven with 300 cycles. At high frequencies, two iron were consistently unsatisfactory. Iron flame hardened at an indicated temperature of 1500 F were generally satisfactory, with one exception, when quenched with water. With an oil quench, the hardness of the cases was below the specified value of 50 Rockwell C at 0.060 in.

Of the structures investigated, one consisting of a dense pattern of extremely small spheroids of cementite responded most satisfactorily to all types of treatment. A microstructure made up of a ferrite matrix and coarsely spheroidized cementite proved least satisfactory. For both flame and induction heating, an increase in heating time produced higher case hardness, a deeper case and a more homogenous microstructure.

Moist Investment Molds

A technique for retaining varying amounts of moisture in plaster-bonded investment molds in order to improve the properties of precision-cast aluminum alloys has been developed by H. Rosenthal and S. Lipson, Frankford Arsenal, Philadelphia. The method was described in their paper "Precision Casting Aluminum in Moist Investment Molds."

The new mold consists of a precoat applied to the wax patterns, over which a backing investment is poured. The backing investment contains a large number of air bubbles to increase its permeability so that the steam generated by the hot metal can escape. Moisture is controlled during wax removal by heating in a steam autoclave.

Increases in tensile strength up to 15% have been obtained for aluminum-copper-silicon alloys as a result of the increased chilling power of the new mold. Moreover, a comparison of this technique with the standard investment process indicates a potential saving in investment material, as well as in labor requirements for investing large numbers of molds.

Magnesium Casting Alloys

"Development of High-Strength Magnesium Casting Alloy ZK61" was

American Felt helps polish Ford plate glass

This huge and complex line grinds and polishes the clear, safe-vision glass made by the Ford Motor Company in its plant in Dearborn, Michigan. There are 60 grinding and 100 polishing machines using 1100 blocks of felt. The ways on each line are leveled to an absolute plate by means of engineer levels set up from the center, so that the ways are definitely not following the curvature of the earth. The tables making up the line are 92 inches wide and 12 feet long, and are automatically latched together, forming a continuous table 600 feet long. Some of the blocks of American polishing felt can be seen in the illustration above. It is a source of satisfaction to American Felt Company to play a part in this operation. Felt is so important to the automotive industry that strict standards were developed for the material, permitting the various types to be correctly chosen for specific applications, and exactly specified when ordering. Many other industries also order from American to those standards. Typical applications, both within and without the automotive industry, include: sealing, wick lubrication, gaskets, washers, anti-squeak strips, dust shields, lining, padding, filtration, polishing, cushioning, insulation, wiping, sound absorption. American supplies felt in sheets or rolls, and also provides precision-cut parts, ready for assembly.

For technical information and illustrative samples, write for special booklet: "S.A.E. Felts."

American Felt Company

TRADE MARK

GENERAL OFFICES:
24 GLENVILLE ROAD, GLENVILLE, CONN.

ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

News Digest

described by J. W. Meier and M. W. Martinson, of the Canadian Bureau of Mines. A comparison of the mechanical properties of various ferrous and nonferrous casting alloys shows that this newly developed alloy has the highest strength-weight ratio found in any commercial casting alloy.

An extensive investigation of various casting alloys based on the magnesium-zinc-zirconium alloy system showed that optimum properties in the as-cast and the heat treated conditions are obtained using alloy ZK61 containing 6 zinc and over 0.7%

ZK61 Compared with Some Standard Casting Alloys

Alloy	Elong., % in 2 In.	Strength-Weight Ratio, 1000 Psi.	
		Ult. Ten. Str.	Yield, Str.
AZ63-HTA	6	21.7	10.9
AZ80-HTA	6	22.0	9.9
AZ92-HTA	2	23.0	13.9
ZK61-AC	12	21.7	10.9
ZK61-RTA	8	22.8	14.1
ZK61-HTA	10	25.5	16.4
SC21-T7	3	13.0	9.3
C1-T62	5	14.2	10.8
G3-T4	14	17.8	9.7
Mn Bronze (AC)	15	14.6	8.9
Al Bronze (HTA)	5	16.0	9.3
"S" Monel (AC)	2	16.7	13.1
Gray Cast Iron (AC)	—	6.9	—
Malleable Iron (HT)	7	10.0	7.5
Low Alloy Steel (HT)	30	14.0	10.8

NOTE: AC — as cast; RTA — room temperature aged; HTA — heat treated and aged

zirconium. Use of high-purity magnesium in the production of ZK61 allows use of a fused chloride mixture as an alloying agent for the introduction of zirconium without excessive flux inclusions. High-purity magnesium also makes possible a higher alloying efficiency because less zirconium is lost due to settling out of impurities.

A heat treatment was developed for ZK61 consisting of a short solution treatment at high temperatures (800 to 932 F) and a longer aging treatment at low temperatures (at or below 300 F). Aging at room temperature, without any prior heat treatment, produces in ZK61 castings a combination of mechanical properties superior to those of any standard

PRODUCT DESIGN STUDIES • NO. 21

WELDED ROCKER ARM

CAST STEEL ROCKER ARM

Cost Reduced 12%
Weight Reduced 5%
Dependability Assured
with STEEL CASTINGS

This is an idler gear rocker arm. It is a part of a steam locomotive booster. Weight before redesign to a steel casting — 147 pounds.

Although the manufacturer was making the rocker arm as a weldment in his own plant, he was interested in discussing the advantages of a steel casting, which he would have to buy outside.

Consultation between the engineering department of the manufacturing company and the steel foundry engineer resulted in a 12% lower cost and 5% lower weight plus other important benefits. A marked increase in dependability was obtained through greater rigidity with toughness, and additional strength where needed — because of better distribution of the metal.

Conversion of some of *your* high-strength parts to steel castings may result in equal if not greater benefits than those shown here.

Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits . . . if you call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

STEEL FOUNDERS' SOCIETY OF AMERICA

920 Midland Building • Cleveland 15, Ohio

News Digest

magnesium casting alloy in the fu heat treated condition.

Properties of Ferrous Materials

In "Composition and Properties Gray Iron," Richard Schneidewi University of Michigan, and R. McElwee, Vanadium Corp. of Ame ica, attempted to re-evaluate the we known Maurer diagram and to redu some of the relationships shown the to a more quantitative and readi usable basis.

A simple mathematical expressi was derived and the authors pr sented graphs to show the limiti compositions with respect to carb and silicon which will cast whi These values are restricted to norm cupola irons, unalloyed and uninoc lated, over a range of section sizes c in sand. A value was proposed to e tend this relationship to superhea air-furnace irons such as are used the malleable industry.

The same authors also presented paper on "Correlation of Propert of Gray Irons," in which a correlati was made between composition measured by the carbon equivalen and the tensile strength and the se tion size for sand castings. In add tion, a method was proposed to com pute probable strength of sand-ca gray irons of varying sections whe alloyed.

Work on "Improved Test Bars f Standard and Ductile Grades of C Iron" was described by Richard Flinn and R. Wayne Kraft, Americ Brake Shoe Co. The authors deve oped a series of Y-shaped test bloc and compared them with AST standard A-48 arbitration bars f pearlitic ductile iron, ferritic ducti iron, Class 50 gray iron and Class gray iron. The Y-block series did no exhibit the shrinkage apparent in th standard specimens; furthermore th Y-block series provided four time the range of cooling rates of the arb tration bars. These tests were recom mended by the authors as an alterna standard.

Corrosion and Stress Corrosion

R. A. Quadt and E. C. Reichard American Smelting & Refining Co presented a paper on "Corrosion an Stress Corrosion Properties of High Strength Aluminum-Zinc-Mag nesium-Copper Casting Alloy." Th

News Digest

self-aging, sand-cast alloy, containing 7.5 zinc, 0.8 copper and 0.4% magnesium, was subjected to various corrosion and stress corrosion tests in 3% aerated sodium chloride solution.

In immersion tests the alloy showed resistance to attack equivalent to the aluminum-5% silicon composition commonly employed where good corrosion resistance is required. Specimens simultaneously corroded and stressed were unaffected by loads up to 80% of yield strength; stress corrosion cracking occurred somewhere between 80 and 90% of yield strength.

In another paper, E. I. Valyi, A.R.D. Corp., presented a review of "Pattern Materials and Production in Precision Investment Casting." Although patterns can be made from waxes, plastics and low-melting alloys, plastic patterns appear to offer the greatest advantage.

High Temperature Materials...

continued from page 9

nickel and iron with aluminum oxide and beryllium oxide.

Metal-Refractory Materials

The Electrochemical Society heard John D. Roach, National Lead Co., describe the "Effect of Chromium on the Oxidation Resistance of Titanium Carbide." He found that a small percentage of chromium in recrystallized titanium carbide improves the resistance of this material to oxidation at high temperatures. At temperatures of 1200, 1560, 2190 and 2550 F, an addition of 5% chromium appeared to give maximum oxidation resistance.

In "Metal Ceramics for High Temperature Applications," W. O. Sweeny, Haynes Stellite Div., presented data on Metamic metal-ceramic, a material consisting of 70 chromium and 30% aluminum oxide. Physical and mechanical properties, current limitations on sizes and shapes that can be produced, various joining methods and applications were reviewed.

The unusual metallic properties of

Maintain Operating Accuracy

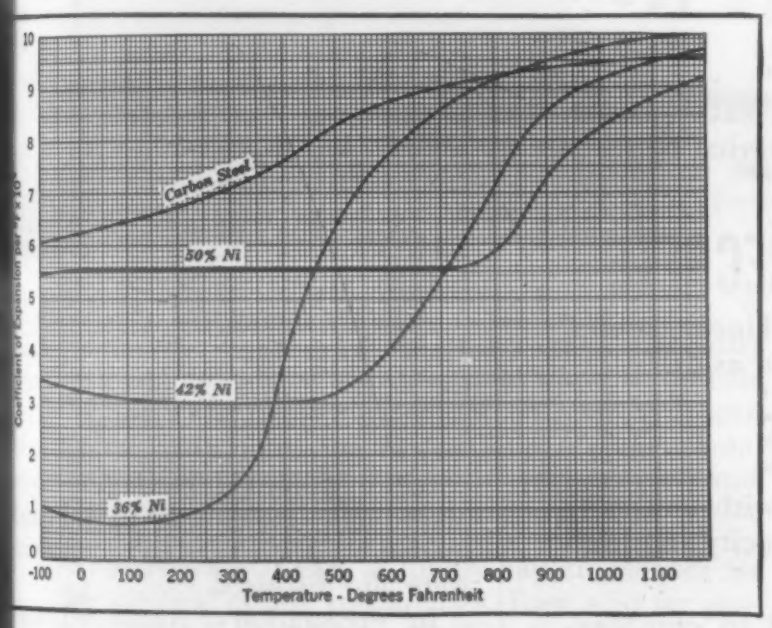
BY USING

Iron-Nickel Alloys

TO CONTROL THERMAL EXPANSION

Any desired coefficient of expansion, ranging from almost zero to a value greater than that of ordinary steel, may be obtained with the iron-nickel alloys. In addition, these alloys are strong, tough, ductile and possess a useful degree of corrosion resistance.

In wide use is a 36% nickel alloy... aptly named "Invar" because its dimensions remain almost *invariable* over the range of atmospheric temperature variations. However, as nickel content goes higher, expansion increases continuously. The chart, below, shows the thermal expansion characteristics of invar and two other high nickel alloys, along with those of carbon steel for comparison.



FABRICATION

Like all austenitic alloys, those of the iron-nickel system respond well to plastic deformation, either hot or cold. They may be welded by any of the commonly used methods, and users report their machining characteristics are very similar to those of other high nickel alloys such as Monel® and Inconel®. A special, free-cutting grade is available to meet exacting machining requirements.

APPLICATIONS

Where dimensional changes with temperature must be minimized, or where such changes must approximate those of other materials of relatively low expansivity, iron-nickel alloys... sometimes modified by other alloying elements... are almost universally used.

For example... in thermostatic bimetal strip, Invar serves as the low expansion side for use up to moderately elevated temperatures. At higher temperatures, the 42% nickel alloy is commonly used. For the high expansion side, special alloys, containing 15-25% nickel, are used extensively because they develop nearly double the expansivity of iron. Iron-nickel alloys are also widely used in glass-to-metal seals, where expansivity of the glass must be closely matched. The 42% nickel alloy, sometimes with added chromium, is used with soft glasses. Hard glasses call for nickel alloys containing added cobalt.

Scores of other iron-nickel alloy applications include bases for giant telescopes, surveyors' tapes, radio condensers, parts for textile machinery and for numerous precision instruments and devices.

Industrial fields of usefulness for the iron-nickel alloys are far from exhausted. These unique materials can be of incalculable value in improving instrumentation and process control, and in the design of new devices. They are available in various forms including wire, rod, strip, sheet, bars and tubing. Send coupon today for additional information on the properties of iron-nickel alloys... they may be the means of improving your products, equipment, or process.

EMBLEM OF INCO SERVICE TRADE MARK

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THE INTERNATIONAL NICKEL COMPANY, INC.

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News Digest

the diborides of titanium, zirconium columbium and tantalum were discussed in "The Metallic Nature of Metal Borides," presented by S. J. Sindeband and Paul Schwarzkopf, American Electro Metal Corp. The metallic nature of these compounds was indicated by data on electrical conductivity, thermal conductivity, Wiedemann-Franz ratio and temperature coefficient of resistivity. Earlier reports from Ohio State University were supplemented by a paper on "Fundamental Concept in Sintering and Properties of Oxide-Metal Cermets," in which T. S. Shevlin presented a theory of wetting and bonding which has been successfully applied to materials composed of chromium and alumina.

Other High Temperature Bodies

The Electrochemical Society also heard a review of the properties of known materials which melt above 4000 F, presented by Gordon R. Finlay, Norton Co. Research Laboratories. In "Refractories for Four Thousand Degrees Plus," he also described methods of production and fabrication for the various carbides, borides, nitrides and oxides.

Another survey was undertaken by Hans Thurnauer, American Lava Corp. In "A Survey of High Temperature Metals and Ceramics," he reviewed properties of various high temperature materials, classifying them according to their ability to withstand oxidation. Their uses and limitations were also discussed.

In "Preparation of Alumina-Titanium Carbide Bodies by Hot Pressing," Harold Barr, George D. Cremer and Walter J. Koshuba, Fairchild Engine & Airplane Corp., reported that mixtures of 70 alumina-30% titanium carbide have been fabricated by hot pressing methods. Tubular specimens capable of being heated by their own resistance were developed.

Preparation, properties and uses of "Stabilized Zirconia Refractories" were covered by O. J. Whittemore, Jr., Norton Co. Research Laboratories. These materials have a fusion range of 4700 to 4800 F, unusually low thermal conductivity (about one-third that of fused alumina and magnesia refractories), relatively good thermal shock resistance, and they are resistant to oxidizing and moderately

If you want results like this...

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DIVERSEY No. 909

Unique Heavy Duty Soak Tank Cleaner

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DIVERSEY EVERITE

Rust and Heat-Scale Remover

Gears courtesy of
Gear Specialties, Inc.
Chicago, Ill.

Steel Gears—Case History

PROBLEM: To remove oil, greases and shop dirt from gears prior to heat treatment and to descale the gears after heat treatment without hydrogen embrittlement and with a minimum of dimensional change. Complete de-rusting of various iron and steel shapes also had to be considered.

PREVIOUS PROCESS: A highly caustic cleaner for the removal of oils and greases. Raw acid for general rust and scale removal. Wire brushing for the removal of heat scale and discoloration from gears susceptible to hydrogen embrittlement and whose dimensional tolerances were very small.

PRESENT PROCESS: Diversey No. 909 for oil and grease removal and Diversey Everite for all descaling and de-rusting operations.

RESULTS: Diversey No. 909 produced decidedly cleaner surfaces than the previously used material and did it in less time! The heat treated work contained no burned oil residues.

The gears which could not be pickled previously due to tendencies for hydrogen embrittlement are safely descaled with Diversey Everite. Wire brushing operations have been eliminated. No attack occurs on the gears in spite of the fact that prolonged pickling is required to remove the heavy scale at the root of the gear teeth. And Everite produces brighter surfaces than were previously obtainable with any method.

MAIL THIS COUPON FOR COMPLETE INFORMATION

THE DIVERSEY CORPORATION
Metal Industries Department
1820 Roscoe Street • Chicago 13, Illinois
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DM2

News Digest

reducing atmospheres. Because (low electrical resistivity at high tem peratures, stabilized zirconia tube have been used as electrical resistor as high as 4350 F.

A paper on " 'Durhy'—An Unusu Silicon Carbide Body" was presente by C. G. Rose, The Carborundum C This material, comprising silicon car bide impregnated with silicon, has a unusual combination of refractor ness, electrical conductivity, abrasio resistance and inertness to mar reagents.

Vapor Deposition

This meeting also featured a serie of papers on "The Formation of Re fractory Coatings by Vapor Depos tion Methods," presented by Battel Memorial Institute. By proper selec tion of reactions and plating condi tions, alloys of most of the refractor metals can be obtained over wid ranges of compositions, thus makin it possible to prepare alloys not ob tained by conventional methods.

Tantalum and columbium coating are readily deposited on both metalli and nonmetallic bases by hydroge reduction of their pentachlorides a temperatures above 1100 F. On re fractory bases, such as molybdenum tungsten and graphite, thermal de composition of the pentachloride and pentabromides can be used t produce coatings of these metal Vanadium deposition is more diffi cult to carry out, but satisfactor deposits of vanadium have bee obtained by decomposing vanadium diiodide at 1800 to 2200 F.

Molybdenum and tungsten coat ings are formed by hydrogen reduc tion of their chlorides. The platinum group metals are deposited by decom position of the carbonyl chloride Rhenium can be deposited by pyro ysis of its volatile chloride and uran um by thermal decomposition of th triiodide stabilized with iodine.

Coatings of the refractory carbide are obtained on metallic or nonmetal lic bases by reduction of metal chlor ides in a hydrogen-hydrocarbon at mosphere under carefully controlled conditions, or by deposition of the metal followed by carburization o the plate. When a metal is to be coated with its own carbide, heat treatment in a hydrocarbon-contain ing atmosphere is often satisfactory.

Coatings of refractory nitrides, bor

IBM gets speedy, precision cleaning of 50,000 different parts . . . with

VAPOR DEGREASING

Courtesy: International Business Machines Corporation, Endicott, N. Y.

Fifteen years ago, the International Business Machines Corporation installed its first vapor degreasing unit in the main plant at Endicott, New York. This modern metal cleaning method, using trichlorethylene, replaced the hand wiping of flat stock and the use of the alkaline dip for the removal of oil and grease.

So successful was this first unit that, today, there are five degreasers in the Endicott plant being used for the thorough cleaning of over 50,000 different parts for the more than 1000 models of IBM business machines, time-recording units, and indicating and signaling devices.

IBM has found that vapor degreasing quickly and easily removes oil, grease and dirt from recesses and holes in even the most intricate precision parts. And the degreasers are used to handle all types of work—from tiny screws and studs to large iron castings—prior to finishing, inspection and assembly. High IBM precision standards are safely met by this precision-like cleaning method.

The excellent results experienced at the Endicott plant of IBM are being duplicated daily in thousands of plants across the country. Perhaps vapor degreasing can mean important economies in time and cost for you. Why not investigate its possibilities today?

News Digest

ides and silicide can be obtained b the reaction of metal chloride wit nitrogen-hydrogen, boron dichloride hydrogen and silicon tetrachloride hydrogen atmospheres at a heate surface under carefully controlle conditions. Where difficulty is en countered in controlling the relativ rates of deposition of metal and non metal, the metal can be deposited firs and then nitrided, borided or silicon ized. Oxide coatings can be obtaine by the decomposition of metal halide or their reaction with a hydrogen carbon dioxide atmosphere.

This work on vapor deposition wa carried out by L. C. Beale, Jr., C. H Powell, I. E. Campbell, D. L. Day, C C. Heim and D. H. Nowicki.

Another Battelle paper, "The Pro tection of Molybdenum from Oxida tion in Air at High Temperatures," was given by C. F. Powell, E. A Beidler, I. E. Campbell, B. W. Gon ser and L. F. Yntema. They found that molybdenum can be made highly corrosion resistant by treatment with a hydrogen-silicon tetrachloride at mosphere at 1800 to 3300 F so as to produce a molybdenum disilicide coating at its surface. One-mil coat ings thus produced have completely protected the base metal for over 4000 hr. in air at 1830 F and over 30 hr. at 3090 F. Thicker coatings within limits, give proportionately longer lives. Although brittle at room temperatures, the coatings have some ductility at a red heat and tend to be self-healing.

Laboratory Open House Held

The Stamford Research Laboratories of American Cyanamid Co., Stamford, Conn., were opened to the public recently for the first time since they were established in 1936.

Visitors who toured the more than 410,000 sq. ft. of floor space saw a variety of exhibits showing how this company's chemicals are used by manufacturers of textiles, leather, paints, petroleum and agricultural products. In addition, the functions and operation of much of the extensive laboratory equipment were demonstrated.

Isn't this a pretty kettle of fish?

SURVEYS reveal an appalling misunderstanding among young people of the "facts of business life." For example, a poll was made among seniors in certain high schools which showed that they believe business profits are "over 50%" of the sales dollar, where actually profits average less than 8%. These students also think that stockholders receive 24% of the sales dollar, where actually it runs less than 3%.

Isn't this a pretty kettle of fish?

A greater part of the 8% of the sales dollar is reinvested in the business to expand and improve plant facilities which protects employment and creates new jobs for more workers.

Such ignorance is alarming. It is unfair to the young people themselves and dangerous to America's future. Such misconceptions open the door to socialism, communism and all the fantasies of the handout or "something-for-nothing" state of the economic dreamers.

Our school teachers say they *want* authentic information on the business system and how it works. Only business itself can supply the facts. You as a business leader in your community must share the responsibility for this misunderstanding. It is our civic duty to help overcome this misconception of everyday economics in the minds of our youth today.

THE YOUNGSTOWN SHEET & TUBE CO. 1900 YOUNGSTOWN 1950 50 YEARS OF SERVICE

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MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

ELECTROLYTIC TIN PLATE - COKE TIN PLATE - WIRE - COLD FINISHED CARBON AND ALLOY BARS - PIPE AND TUBULAR PRODUCTS - CONDUIT - RODS - SHEETS - PLATES - BARS - RAILROAD TRACK SPIKES.

News Digest

News of Engineers

Robert T. Wood has been named chief metallurgist of magnesium products for Aluminum Co. of America. He was formerly chief engineer for American Magnesium Corp., an Alcoa subsidiary. It was also announced that Dr. *Kent R. Van Horn*, assistant director of research, will become associate director of research, effective Aug. 1, 1950. He will be transferred to the central headquarters of Alcoa's research organization at New Kensington, Pa.

Speer Carbon Co. has announced several changes in its organization. *A. H. Toronski*, assistant chief plant engineer, is now chief engineer — carbon and graphite products. *Harold Higgs*, recently chief of electronic service for the Bell Aircraft Corp., has joined the company as chief electronics engineer of the Jeffers Electronics, Inc., a wholly-owned subsidiary of Speer. *Max F. Balcom*, chairman of the board of Sylvania Electric Products, Inc., was elected a director of Speer. And *John W. Lohnes*, previously manager of sales for the International Graphite & Electrode Corp., a subsidiary of Speer, was appointed vice president in charge of carbon and graphite sales for both Speer and International Graphite.

Edmund A. Watson has been named general improvement engineer of the American Car & Foundry Co. He succeeds *John W. Sheffer*, who is retiring after 42 years of service with ACF.

The General Electric Co. has announced several appointments made recently. *Clarence H. Linder*, assistant to the general manager of G.E.'s Apparatus Dept., is now manager of engineering and acting manager of manufacturing of the Affiliated Manufacturing Companies' Dept. *Frank Gimblette*, manager of G.E.'s Taunton, Mass., plant, was promoted to the company's Plastics Div.'s manufacturing headquarters staff. *Thomas H. Wey*, until recently in charge of production engineering for the Murray Body Corp., succeeds Mr. Gimblette as manager of the Taunton plant. *L. D. Whitescarver* has been named assistant manager of the Lynn, Mass., Turbine & Gear Sales Div. of G.E.'s Turbine Divs. Succeeding him as manager of the Fitchburg, Mass., Turbine Sales Div. is *F. S. Kohl*. And *Thomas Sproule*, production manager of the Fitchburg Works of G.E.'s Welding Div., is now assistant manager of manufacturing for the Fitchburg Turbine and Welding Divs.

(Continued on page 120)

Rolling finer Alloy Bars at 27 miles per hour

This continuous, high-speed 10-inch mill is the most advanced bar-rolling equipment in operation today. A mechanical marvel, it can reduce a billet to a finished bar in approximately 20 seconds. The hot steel travels continuously in a straight line from the furnace all the way through 18 roll stands to the run-out table with no reversing or looping-back required.

There are four principal reasons why this mill produces alloy steel bars of superior quality.

1. Alternate vertical and horizontal rolls in the roughing stands are arranged to eliminate any twisting or deflection in the bars.

2. Guides are designed to avoid scratching or damaging the surface of the bars between passes.

3. The heating furnaces that feed into the mill are designed to hold billets at rolling temperature for relatively short periods, resulting in less scale and decarburization.

4. The high rolling speeds minimize the temperature drop and help to develop a uniform tolerance and section in the finished bars.

This mill is typical of the many postwar improvements Bethlehem has made in its facilities for producing alloy steels. Also included are: modern soaking pits, hot scarfing machines, controlled-cooling facilities, heat-treating furnaces for bars in straight lengths and coils, and finishing facilities.

Bethlehem makes high-quality alloy steels in a complete range, including all AISI grades and special analyses for every purpose.

BETHLEHEM STEEL COMPANY

BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor

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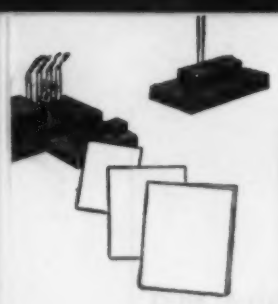
BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL



MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Special Steels. Allegheny Ludlum Steel Corp., 8 pages, illustrated, No. 1a/1. Properties of the stainless steels, electrical steels, silicon steels, magnetic materials, tool steels and "Carmet" carbide metals produced by this company. (1)

Stainless Steel. Allegheny Ludlum Steel Corp. Complete technical and fabricating data, and applications of this company's stainless steel products. (2)

Stainless Steels. Armco Steel Corp., 44 pages, illustrated. Chemical analyses, physical characteristics and uses of this company's stainless steels. Detailed data on corrosion resistance, scaling resistance, mechanical properties, creep strength, etc., is included. (3)

Abrasion-Resistant Alloy. Electro-Alloys Div., American Brake Shoe Co., 6 pages, illustrated. Physical properties, uses and advantages of castings of Thermalloy HC-250, an abrasion-resistant alloy. Includes case history data on industrial applications, and information on machining and high temperature service. (4)

Free Machining Steel. W. J. Holliday & Co., Inc., 6 pages, illustrated. Characteristics and uses of X1515 Speed Case Plate (low-carbon) and X1545 Speed Treat Plate (medium-carbon), two free machining steels. (5)

Stainless-Clad Steel. Ingersoll Steel Div. of Borg-Warner Corp. Folder describes Ing-Aclad, a 20% cladding of stainless steel bonded to a backing of carbon steel. Manual of fabricating and welding procedure also available. (6)

Clad Steels. Lukens Steel Co., 68 pages, illustrated. Compositions, mechanical properties, corrosion ratings and applications of nickel-clad, stainless-clad, Inconel-clad and Monel-clad steels. (7)

Alloy Steel. Joseph T. Ryerson & Son, Inc. Booklet contains helpful data for specifying and buying alloy steels. (8)

Screw Steel. Joseph T. Ryerson & Son, Inc., 2 pages. Describes Ledloy, a lead-bearing, open-hearth steel that machines from 30 to 50% faster than the fastest-cutting screw steel previously available. Has good ductility, strength and case-hardening qualities. (9)

Alloy Steels. Wheelock, Lovejoy & Co., Inc., 3 pages. Presents data including composition limits, heat treating instructions, physical properties, sizes, applications, etc., for AISI, Hy-Ten and SAE alloy steels. (10)

Nonferrous Metals

Forging Alloys. Bridgeport Brass Co. Characteristics of various forging alloys, including Duronze III, silicon bronze, naval brass, manganese bronze and Muntz metal. Includes chemical composition, machining qualities and applications. (11)

Low Melting Alloys. Cerro de Pasco Copper Corp., 40 Wall St., New York 5, N. Y. Loose-leaf binder and informative engineering literature on Cerro (low-temperature melting) alloys and special methods of application which have been useful in many phases of manufacturing. Free when requested from Cerro de Pasco on company letterhead.

Thermostatic Bimetal. W. M. Chace Co., 4 pages, illustrated, No. 1a/10. Properties of Chace thermostatic bimetals, and detailed formulae and calculations used in their application to temperature responsive devices. (12)

Spring Alloy. Elgin National Watch Co., Industrial Products Div., 2 pages. Composition and properties of cobalt-chromium-base spring alloy, Elgiloy, having high corrosion resistance, set and fatigue resistance, hardness and elasticity. (13)

Welding Nickel Alloy. Illium Corp., 4 pages, No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base corrosion resisting alloy. (14)

Nickel Alloy Corrosion. International Nickel Co., Inc., Development & Research Div., 4 pages, illustrated, No. T-6. Results of extensive corrosion tests on nickel and alloys using caustic alkalies. (15)

Silver Babbitt. National Bearing Div., American Brake Shoe Co. Physical properties and operating characteristics of N-B Silver Babbitt for bearings. Also instructions on preparation of shells for good bonding and on pouring. (16)

Nonmetallic Materials and Parts

Graphite Parting Compound. Acheson Colloids Corp., 4 pages, illustrated, No. 42 Describes uses of Dag Colloidal graphite as a parting compound to prevent sticking of two surfaces. (17)

Felts. American Felt Co. Booklet labeled "S.A.E. Felts" gives technical standards of felt materials adopted by automotive industry and used by many other industries. Samples also included. (18)

Hard Rubber and Plastics. American Hard Rubber Co., 60 pages, illustrated. Complete technical data on all grades of Ace hard rubber and plastics. (19)

Ceramics. American Lava Corp., 4 pages, No. 248. Chart of mechanical and electrical properties of AlSiMag ceramics. (20)

Plywood. Douglas Fir Plywood Assn. Useful applications of plywood for solving production, construction, maintenance and packaging problems. (21)

Silicone Compound. Dow Corning Corp., 4 pages, illustrated, No. 1. Complete data on D.C. Antifoam A, silicone compound for killing foam in aqueous systems. Typical applications included. (22)

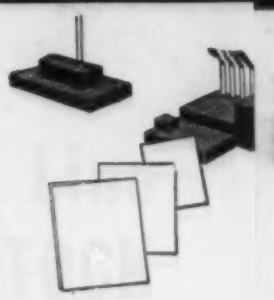
Plastic Resin. Dow Chemical Co., Plastics Div., 8 pages, illustrated. Presents complete data on Saran, a plastic resin for injection molding. (23)

Plastics. E. I. du Pont de Nemours & Co., Inc., Polychemical Dept. Physical characteristics of nylon and other plastics. Also gives cost-saving applications. (24)

Resins and Molding Compounds. Durez Plastics & Chemicals, Inc., 8 pages, illustrated.

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 117.

MANUFACTURERS' LITERATURE



Lists physical properties and applications of 23 Durez phenolic molding compounds and describes 15 different fields of application for phenolic resins. (25)

Laminated Thermosetting Plastics. The Formica Co., 16 pages, illustrated, No. 1b/9. Descriptions and properties of various Formica grades. Includes glass fibre, silicone, chemical-resistant synthetic fibre, cotton mat, arc-resistant and special punching grades. (26)

Silicone Rubber. General Electric Co., Chemical Dept. Information on G.E. silicone rubber, suitable for bushings, gaskets, heat sealers and shock absorbers. (27)

Rubber. B. F. Goodrich Chemical Co. (Div. of B. F. Goodrich Co.), 8 pages, illustrated, No. 1c/4. Properties and specific uses of Hycar rubber products, including vulcanizates, latex, plasticizers and phenolic blends. Also Good-rite Resin 50 and Geon polyblends. (28)

Corrosion Resisting Plastic. Haveg Corp., 8 pages, illustrated. How various grades of Haveg material, consisting of asbestos and synthetic resin, are used to produce corrosion-resisting process equipment. (29)

Cemented Carbide. Kennametal, Inc., 2 pages, illustrated, No. 284. Reports high temperature performance of tube fabricated from Kentanium K140A, new heat-resisting, cemented titanium-carbide (30)

Metal Hydrides. Metal Hydrides, Inc., 4 pages. Describes metallurgical and chemical hydrides. Indicates their use in alloying, producing hydrogen, reduction of organic and inorganic compounds, condensation reactions, etc. (31)

Wear-Resistant Materials. Norton Co., 4 pages. Describes physical and chemical properties of five extremely hard, chemically inert, non-corrosive materials used in slurry pump liners, cylinder liners, wear plates, etc. (32)

Plastics. Richardson Co., 24 pages, illustrated. Describes uses, production processes, etc., of numerous types of plastics. (33)

Polyester Resins. Rohm & Haas Co., Resinous Products Div., 21 pages. Describes physical properties of liquid and cured Paraplex Resins. Recommends compounding and curing techniques. Lists methods of laminating, molding, casting and fabricating, and uses in cementing, caulking and impregnating. Suggests numerous applications. (34)

Closed-Cell Rubber. Rubatex Div. of Great American Industries, Inc., No. RBS-12-49. Information on Rubatex closed-cell rubber, available in soft, medium and firm forms and on natural and synthetic stocks, for gasketing, cushioning or vibration-damping application. (35)

Neoprene. Rubber Chemical Div., E. I. du Pont de Nemours & Co., Inc., 12 pages, illustrated, No. 43. Discussion of the use of Neoprene in parts necessitating high chemical resistance such as hose, diaphragms and protective coatings. Includes extensive tabular data. (36)

Sponge Rubber. Sponge Rubber Products Co., 12 pages, illustrated. Specifications and descriptions of products made from Spongex, including sheet sponge rubber, die cut shapes, cord, tubing, strips, molder forms and pad stock. (37)

Colored Rubber. Stalwart Rubber Co., 4 pages, illustrated. "Your Color in Rubber" outlines this company's facilities for duplicating any color in rubber, regardless of shade or tone, without altering other characteristics. (38)

Molded Ceramics. Star Porcelain Co. Brief survey of the technical characteristics of molded ceramic products for electrical wiring, electrical heating and special applications. (39)

Technical Plastics. Synthane Corp., 20 pages, illustrated, No. 1b/15. Properties and applications of this company's technical plastics. Available forms, specifications and tolerances listed. (40)

Inert Plastic. U. S. Gasket Co., Teflon Products Div., Catalog No. 300. Gives complete specifications and description of available stock of Teflon, a plastic featuring chemical inertness, high dielectric strength and good adhesion resistance. (41)

Carbon Graphite. U. S. Graphite Co., 40 pages, illustrated. Catalog gives complete data on Graphitar, a carbon-graphite nonmetallic product with self-lubricating properties and low coefficient of friction that resists chemical attack, is as hard as steel, lighter than magnesium, and will not warp. (42)

Polyester Resins. U. S. Rubber Co., Naugatuck Chemical Div., 18 pages. Detailed properties and applications of Vibrins, thermosetting polyester resins. Fabricating information includes details on pressure laminating and casting. Price schedule included. (43)

Felt. Western Felt Works, 32 pages, illustrated. History of manufacture and uses of felt, including brief description of present-day methods and applications. (44)

Metal Parts • Forms

Aluminum Extruded Shapes. Aluminum Co. of America, 12 pages illustrated, No. AD-229. Shows design potentialities of versatile aluminum extrusion process. Includes production applications, cost considerations and terminology and data helpful in ordering extruded shapes. (45)

Aluminum Die Castings Design. Aluminum Co. of America, Pittsburgh 19, Pa., 189 pages, illustrated. Price $1.00. Aimed at buyer of light-metal die castings. Data on die casting process and equipment, alloys used, design rules and finishing and machining considerations. Requests should be sent directly to the Aluminum Co.

Aluminum Parts. Aluminum Goods Manufacturing Co., 56 pages, illustrated. Comprehensive catalog covers this company's extensive facilities for producing aluminum parts, the technical services available and a wide range of products. (46)

Precision Forms. American Brass Co., Waterbury Brass Goods Branch. Data on complete engineering and toolmaking facilities for precision stamping and press drawing of copper, brass, nickel silver and other metals. (47)

Certified Die Castings. American Die Casting Institute, Inc. Describes plan whereby producers of zinc alloy die castings whose output is subject to regular sampling and analysis (A.S.T.M. specifications) can use special labels on shipments. Plan intended to protect buyer of die castings. (48)

Bronze Castings. American Non-Gran Bronze Co., 16 pages, illustrated. Production of bronze castings described, including machining facilities which make possible company's precision contract manufacturing. Shows a number of typical products. (49)

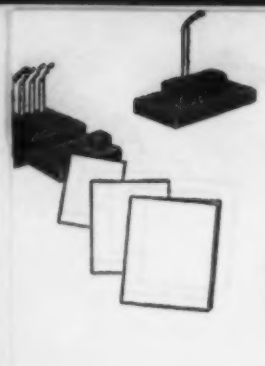
Precision Investment Castings. Arwood Precision Casting Corp., 16 pages, illustrated. Informative article on precision investment castings. Includes table of alloys recommended as most adaptable for this process. (50)

Beryllium-Copper Springs. The Beryllium Corp. Details on beryllium-copper as a corrosion- and fatigue-resistant, high elastic strength spring material with good formability and electrical properties especially adaptable for instrument springs. (51)

Steel Forms. Bethlehem Steel Co., 4 pages illustrated, No. 1a/8. Advantages of this company's cold-formed shapes; Mayari R low-alloy, high strength steel; rolled-and-forged circular products; drop, press and upsetter forgings; pierced forgings; "bethanized" wire; and bolts and nuts. (52)

Steel Tubing. Bundy Tubing Co., 20 pages, illustrated. Mechanical and corrosion properties, fabricating and finishing characteristics, specifications and typical fabricated parts of Bundyweld double-walled, copper-coated steel tubing. (53)

Insert Tools. Carboloy Co., Inc., 6 pages.



MANUFACTURERS' LITERATURE

Supplement to Catalog No. GT-200 describes expanded line of insert tools with mechanically-held solid Carboloy cemented carbide bits, in standard shapes, and their clamping devices. (54)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pages, illustrated. Physical properties, corrosion resistance and available sizes of this company's stainless steel tubing. (55)

Precision Molded Plastics. Consolidated Molded Products Corp., 8 pages, illustrated. Describes this company's facilities, experience and equipment for producing compression-, transfer- and injection-molded plastics. (56)

Die Castings. Doehler-Jarvis Corp., 4 pages, illustrated. Advantages of the die-cast aluminum automobile door panel developed by this company. Discusses possible future applications of large die castings. (57)

Aluminum and Magnesium Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" describes modern machines, techniques and testing devices for rapid, economical aluminum and magnesium casting. (58)

Investment Castings. Engineered Precision Casting Co., 4 pages, illustrated. Describes Epco precision investment castings. (59)

Electrical Contacts. Fansteel Metallurgical Corp., 36 pages, illustrated. Fundamental notes on contact design and properties, advantages and principal uses of Fansteel electrical contact grades. Also discusses assembly methods, including riveting, spinning, upsetting, spot and projection welding, and brazing. (60)

Flexible Tubing. Flexible Tubing Corp., 8 pages, illustrated, No. 5-4. Applications and performance data on Spiratube, new flexible tubing for ventilation and materials conveying. (61)

Stainless Tubing. Peter A. Frasse & Co., 12 pages. Information on machinability of seamless mechanical tubing. Includes this company's recommendations for tool design with pertinent data. (62)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pages, illustrated, No. 108. Characteristics and uses of Graphalloy self-lubricating bushings. Clearances, materials selection and other design data given. (63)

Gray Cast Iron. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (64)

Precision Castings. Gray-Syracuse, Inc., 4 pages, illustrated. Shows various small parts precision-cast of brass, bronze, beryllium, copper, and carbon, stainless, tool and high-temperature steels. (65)

Zinc Die Castings. Gries Reproducer Corp., 4 pages, illustrated. Detailed specifications of Junior and Senior type GRC rust proof and corrosion resistant nonferrous zinc alloy wing nuts and a variety of small zinc die castings, injection moldings, etc. (66)

Helical Compression Springs. Instrument Specialties Co., Inc., 2 pages, illustrated. How to obtain time- and money-saving "engineer's assortment" of 100 beryllium copper helical compression springs for development work. (67)

Bearing Design. Johnson Bronze Co., Sleeve Bearing Headquarters, illustrated. Detailed information and considerations necessary for good bearing design. (68)

Welded Steel Tubing. Jones & Laughlin Steel Corp., 16 pages, illustrated, No. AD-64. Describes manufacture, advantages and uses of Electricweld tubing. Includes tolerances, bending and finishing data and selection factors. (69)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Detailed information on physical and electrical properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Includes tables of available reel sizes. (70)

Cold Drawn Shapes and Shells. Linde Air Products Co., 2 pages. Discusses types of Prest-O-Lite cold-drawn shapes and shells which can be supplied, including materials and dimensional ranges. (71)

Die Castings. Litemetal DiCast, Inc., 12 pages, illustrated. How to select best light metal alloy for die casting. Shows this company's facilities for producing aluminum and magnesium pressure die castings. (72)

Castings. Meehanite Metal Corp., 8 pages illustrated, No. 31. Extensive coverage of industrial applications of Meehanite castings. Test data and charts included. (73)

Tungsten Carbide Shapes. Metal Carbides Corp., No. 50-G. Shows 1325 different sizes of standard solid tungsten carbide blanks, bars, strips, rods, tubes, bushings, rings, flats, tips, disks and special shapes carried in stock for immediate shipment. (74)

Investment Castings. Microcast Div., Austenal Laboratories, Inc., 2 pages, illustrated. Shows typical parts made by precision casting of high-temperature, difficult-to-machine alloys. (75)

Plastic Pipes and Fittings. Elmer E. Mills Corp., 4 pages, illustrated. Describes chemical resistance and physical properties of Mills-Plastic pipes and fittings, produced for a wide variety of chemical and industrial uses. (76)

Nonferrous Powder Metals. New Jersey Zinc Co. Gives properties and uses of nonferrous powder metals, and includes 14 case histories illustrating applications in which costs were cut. (77)

Zinc Alloy Die Castings. New Jersey Zinc Co., 28 pages, illustrated. Principal features of Zamak-3 and Zamak-5 zinc alloy die castings, their method of production, and typical applications. (78)

Precision Castings. Ohio Precision Castings, Inc., 12 pages, illustrated. Application reports on company's precision plaster mold castings as used by several manufacturers for close tolerances, smooth surfaces and economy. (79)

Steel Tubing. Ohio Seamless Tube Co. Informative booklet describes many methods of fabricating and forging steel tubing. (80)

Alloy Tube Supports. Ohio Steel Foundry Co., 8 pages, illustrated, No. TS-49. Describes numerous types of tube supports cast from heat and corrosion resistant steel. Includes properties of Fahrite grade N-3 chromium-nickel alloy and design essentials of tube supports. (81)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pages, illustrated. Describes Phoenixspun method for producing spherical and extra deep-drawn contours in various diameters, and in hard metals up to ⅜-in. thickness. (82)

Aluminum Extrusions. Reynolds Metals Co., Technical Editorial Service, Louisville, Ky., 138 pages, illustrated. "Designing with Aluminum Extrusions" explains engineering principles involved, with examples of effective extrusion design and manufacturing possibilities. Available free when requested from Reynolds on company letterhead.

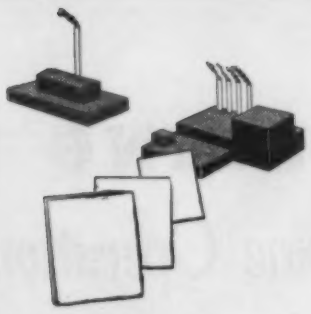
Plastics Forms. Rogers Corp., 12 pages, illustrated. Catalog of materials and services available. Two molding compound series described. Forms include molding boards, laminated sheets and punchings, and preshaped preforms. (83)

Small Tubing. Superior Tube Co., No. 31. Describes this company's seamless and Weldrawn (welded and drawn) tubing available in all practical metals and in outer diameters from 0.010 to 0.625 in. (up to 1⅜ in. in some analyses.) (84)

Sheet Metal Working. Roland Teiner Co., Inc., 4 pages, illustrated. Describes this company's facilities for sheet metal working of all metals, including stainless steels. (143)

Stainless Steel Tubing. Trent Tube Co., 16 pages, illustrated. Describes facilities for producing Trentweld stainless steel, Monel and Inconel tubing in sizes from ⅛ to 22 in. in dia. in long lengths, or up to 30

MANUFACTURERS' LITERATURE



Contact Welding Electrodes. North American Philips Co., Inc. Detailed technical and production data on new contact welding electrode said to give better quality and easier welding. Prices included. (135)

Adjustable Feet. Ohio Nut & Bolt Co., 4 pages, No. 483. Specifications of this company's FR and FS (scalloped rims) adjustable feet, used as leg leveling, adjusting or clamping screws. (136)

Engineered Fasteners. Shakeproof, Inc., 8 pages, illustrated. Detailed specifications of complete line of lock washers, sems thread-cutting screws, Q-two fasteners, etc. (137)

Special Fasteners. South Chester Corp., 28 pages. Data on Southco blind rivets, anchor nuts, panel fasteners, door-retaining nuts, and other fasteners used to join metal-to-metal, metal-to-plywood, etc. (138)

Self-Locking Nuts. Standard Pressed Steel Co., illustrated. Pamphlet describes features and applications of Flexloc locknuts, listing prices and specifications of popular sizes. (139)

Fasteners. Townsend Co., 12 pages, illustrated. Shows many of this company's wire fasteners, emphasizing wide variety of shapes, sizes and heads covering numerous fastening problems. (140)

Forging • Forming • Machining

Forged Metal Quality. Drop Forging Assn., 50 pages, illustrated. Traces metal quality through progressive forging operations, emphasizing improvement in physical properties achieved by hot working. Several hot working processes described in detail. (141)

Metal Forming. Hydropress, Inc., 12 pages, illustrated. Details on Marform process for metal forming by drawing, including explanation of process, applications, advantages and cost analysis comparing it with conventional methods. (142)

Calculator. Wales-Strippit Corp. Free slide rule type of calculator enables rapid determination of cost and time of each part and whole run on Wales Fabricator. (144)

Melting • Casting • Molding

Plastic Injection Molding. Reed-Prentice Corp., 4 pages, illustrated. Complete specifications, features and engineering drawing of company's 10J-60-oz. plastic injection molding machine. (145)

Plastics Molding Press. F. J. Stokes Machine Co., 4 pages, illustrated, No. 503. Description and specifications given for completely automatic plastics press. Typical parts shown. (146)

Inspection • Testing • Control

Hardness Tester. Ames Precision Machine Works, 6 pages, illustrated. Describes precision portable hardness tester Model 4 for testing rounds and flats up to 4 in. Other models and prices are also listed. (147)

Quality Control Indicator. General Electric Co., Apparatus Dept., 4 pages, illustrated, No. GEC-629. Describes operation and uses of new quality control indicator which continuously checks reject rate on mass-production lines. (148)

Furnace Atmosphere Indicator. Claud S. Gordon Co., 2 pages, illustrated. Describes device which quickly indicates any deviation from desired furnace atmosphere. (149)

Surface Pyrometer. Illinois Testing Laboratories, Inc., No. 4257. Describes Alnor Pyrocon, a pyrometer which gives quick, accurate readings of all surface temperatures, metallic or nonmetallic, flat or curved, stationary or revolving. (150)

Microphotometer. Jarrell-Ash Co., No. 1-5. Specifications for Jaco Projection Comparator Microphotometer, a flexible instrument offering many advantages to the spectrographer. (151)

Temperature Control. Leeds & Northrup Co., No. ND44 (1). Information on Micromax electric control pyrometers and recording controllers for regulating, indicating and recording temperatures. (152)

Pyrometer Indicator. Thermo Electric Co., 4 pages, No. 25. Technical features and prices of several models of pyrometer indicators for various temperature ranges. (153)

Combustion Safeguard. Wheelco Instruments Co., 4 pages, illustrated, No. F2-1. Describes new Model 1300 Flame-otrol combustion safeguard for industrial furnaces, ovens, boilers, kilns and other heating equipment. (154)

Hardness Tester. Wilson Mechanical Instrument Co., Inc. Information on Tukon Testers for micro-identation hardness testing. Three models cover full range from micro to macro hardness testing using loads from one gram to fifty thousand grams. (155)

News Digest

continued from page 112

John C. Cotner has been appointe president of The Hydraulic Press Manu facturing Co. In 1949 Mr. Cotner serve as president of Consolidated Industries.

The retirement of *Charles A. Dou* as vice president of Westinghouse Electri Corp. has been announced. He serve with Westinghouse for 43 years.

William A. Kissock was elected vic president of industrial relations of Hot point, Inc. He previously had been man ager of the department.

The appointment of *William A. Muss* as supervisor of the electronics laborator at Southwest Research Institute occurr recently. Mr. Mussen was responsible fo various phases of radio-proximity fus development and instrumentation in th U. S. Naval Ordnance Laboratory.

Charles M. Kimball recently was electe to the office of president of the Midwe Research Institute.

Horizons, Inc. has announced the ap pointment of Dr. *Jacob L. Snoek*, noted Dutch scientist and physicist, to its physic department staff.

Fred M. Gillies was elected to the posi tion of executive vice president of Acme Steel Co. Until a few months ago he had been works manager of Inland Steel Co.

Harbison-Walker Refractories Co. an nounces the appointment of *G. G. Coolidge* as executive assistant to the president. Mr. Coolidge a short time ago relinquished his title as vice president in charge of sales due to company retirement policies, but will continue to retain his directorship.

Robert C. Medl has joined the staff of the Quaker Chemical Products Corp. as technical director. He was previously vice president and technical director of the McCormack-Medl Corp.

The United States Steel and Carnegie Pension Fund, a Pennsylvania corporation, announced the election of *A. R. Mathieson* as president and treasurer, *William C. Butler* as comptroller and secretary, *G. L. Thomas* as supervisor of pension administration, and *E. V. Russ* as supervisor of insurance benefits administration and assistant secretary.

John N. Welsh, director of engineering service of Hall Laboratories, Inc., has been named associate director of the firm. Mr. Welsh will continue in his capacity as director of engineering service.

Raybestos-Manhattan, Inc. has announced the recent election of new officers. *George R. Weber*, vice president and a director, has added the duties of treasurer, succeeding *W. H. Dunn*, who retired. *W. S. Simpson* was named secre-

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FOR PERMANENCE... Hussey Copper and Brass are the *ageless* metals. With unmatched corrosion resistance as a basic physical characteristic, these metals retain their original beauty for the lifetime of your product.

For Low Product Costs . . . Versatile Hussey Copper and Brass are easy and fast to form and to fabricate. They make possible production time-savings whether the fabrication process is soldering, brazing, riveting, crimping, bolting, screwing or laminating. Compare . . . and see how Hussey Copper or Brass does your job better . . . and faster.

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Our 102nd year
1848-1950

News Digest

tary, and *W. Ward Kievit* a director the corporation.

Lloyd J. Hughlett has joined the s of Arthur D. Little, Inc., where he w be engaged in studies leading to progra for regional economic development. M Hughlett formerly served with McGra Hill International Corp.

North American Philips Co., Inc. h promoted *Rudolf Lowit* to the positi of vice president in charge of its El Div. He had been general manager the division.

M. A. Williamson has joined W Diver & Crowe, Inc. as a vice presid He previously had been a vice presid of McGraw-Hill Publishing Co.

The election of *E. W. Donkel* as pre dent of Kent-Owens Machine Co. h been announced. Mr. Donkel, forme vice president and general manager, fi the post left vacant by the death of h father. At the same time *Walter Strehlau* was named assistant secretary.

Clyde O. DeLong, sales manager of t Plastics Div. of The B. F. Goodrich C has been promoted to the position general manager of the division in char of manufacturing and sales.

Automatic Steel Products, Inc. h elected *H. O. Holland* vice president charge of sales of all divisions of t corporation. He had been director sales. It was also announced that *Joh E. Carnahan* was named vice president the Spun Steel Div. of the corporati

George T. Fraser has received the ap pointment of assistant manager of To Steel Sales for Crucible Steel Co. America. Mr. Fraser, formerly manag of Crucible Rexalloy sales, will now mai his headquarters in Syracuse, N. Y.

Borg-Warner Corp. recently elected t following officers: *R. W. Dose,* secreta *Mathew Keck,* treasurer; and *Leon Heidgen,* assistant secretary and assista treasurer.

Robert E. Ward has been appointe manager of the foundry at the Eclips Pioneer Div. of Bendix Aviation Cor Mr. Ward previously was director metallurgy for Eclipse-Pioneer. At th same time *Ralph D. Ferguson,* assistan manager of the foundry, was made sale manager.

Walter Guy Robbins, president of th Carboloy Co., Inc., died of a heart attac while on a business trip in Schenectad N. Y.

The death of *George R. Probst,* man ager of Steam Turbine Sales for Worth ington Pump & Machinery Corp., ha been announced.

Cost-conscious product designers today are scrutinizing materials' costs and properties as never before—to insure the selection of the *right* material for every job.

You, too, may be looking for a fresh approach to new methods, new materials . . . perhaps plastics . . . to help you produce better, faster-selling products, at lower cost.

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News Digest

News of Companies

A. E. Zeisel has announced the formation of *Frigilatem Welding Alloys, Inc.*, located at 1516 Corlies Ave., Neptune, N. J. The company will develop and merchandise new and improved low temperature welding rods and fluxes, both gas and arc, for all metals and for all industries.

Industrial Chemical & Equipment Co. has moved from Builders Exchange to new and larger quarters at 205 11th Ave. South, Minneapolis 15.

The manufacturing activities of *American Magnesium Corp.*, Cleveland and Buffalo—the magnesium fabricating subsidiary of *Aluminum Co. of America*—have been assumed by Alcoa, and American Magnesium Corp. is now inactive. Operations at both Cleveland and Buffalo are being continued under Alcoa management.

The *American Can Co.* has removed its general headquarters staff and facilities from 230 Park Ave. to a new building at 100 Park Ave., New York City. The move also included the Atlantic division sales and the Metropolitan sales organizations.

Entry into the injection molding field has been announced by the *Panelyte Div.* of *St. Regis Paper Co.*, New York 17. One machine for such production is now in operation at the Trenton, N. J., plant of the division, and a second being installed is expected to be capable of producing the largest single injection molded pieces yet attained. Additional equipment for this new operation will be installed progressively this year. Coincidentally, the division has ceased production of decorative Panelyte at Trenton and it will now be produced at the Kalamazoo, Mich., Panelyte plant. This plant is expected to attain capacity operations by early Fall. It was also announced that the *Panelyte Div.* of *St. Regis Paper Co. (Canada) Ltd.* has just commenced construction of a new plant at St. Johns, Quebec, which will supply the requirements of the Canadian market.

Pressed Steel Car Co., Inc., Chicago, has acquired the following steel products manufacturing companies: *Rice & Adams Corp.*, Buffalo, N. Y.; the *C. R. Jahn Co.*, Savanna, Ill., which will shortly move its headquarters to Pressed Steel Car's Mt. Vernon, Ill., plant; and the *Erie Manufacturing Co., Inc.*, Chicago, which will operate as a division of Pressed Steel Car at its present plant but with larger facilities. The transactions included most of

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LINDBERG HARDENING FURNACE—eliminates finishing due to scale and decarb with simple accurate atmosphere control.

LINDBERG TEMPERING FURNACE—allows you to obtain the exact "Rockwell Hardness" required for each specific tool or die.

For tools and dies requiring high speed tool steel—investigate the Lindberg "L" Type combination preheat—high heat Furnace.

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News Digest

the assets of the three companies, with the exception of their buildings and real estate.

Plans to enter the field of limited fabrication of seamless and welded tubing, in addition to its primary work of manufacturing such tubing, were announced by the *Babcock & Wilcox Tube Co.*, Beaver Falls, Pa. The types of fabrication to be handled will include bending; end forming, such as swaging, upsetting, flaring and expanding; flash-butt-welding for safe-ending and making long length tubing; production of tubing with various cross section shapes; and other specialty tube work.

News of Societies

The *American Society for Metals* recently elected the following officers to serve for the year 1950-51: president—Walter E. Jominy, staff engineer, Chrysler Corp.; vice president—Dr. John Chipman, head, Dept. of Metallurgy, Massachusetts Institute of Technology; secretary—W. H. Eisenman; and treasurer—Ralph L. Wilson, chief metallurgist, Timken Steel & Tube Co.

Dr. Harvey N. Davis, president of *Stevens Institute of Technology*, has announced his decision to retire as of Sept. 1, 1951, or sooner if a new president can be named at an earlier date. Dr. Davis has served as president of Stevens for 23 years.

Two new officers have been named for the *Electrochemical Society*. They are: president—Dr. Charles L. Faust, head of electrochemical engineering research at Battelle Memorial Institute; and vice president—R. J. McKay, chemical engineer for the International Nickel Co., Inc.

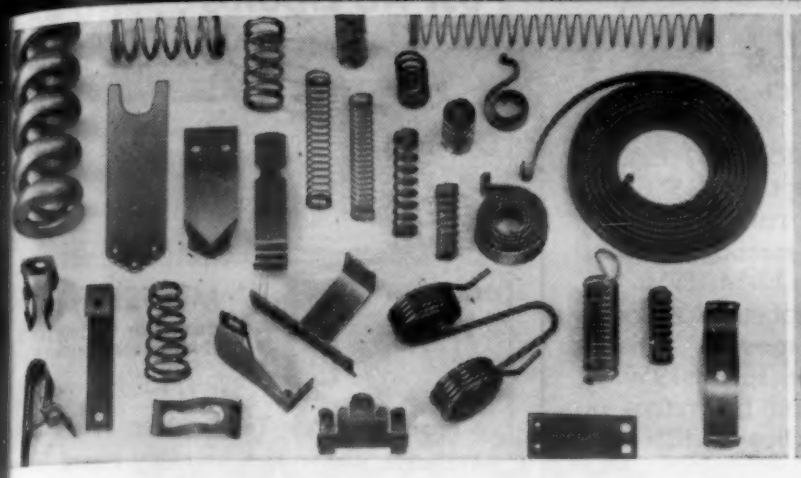
Dr. Roman Smoluchowski has been promoted to professor of metallurgical engineering at *Carnegie Institute of Technology*, effective Sept. 1, 1950. Dr. Smoluchowski is a member of the staff of the Metals Research Laboratory at Carnegie.

The *Industrial Furnace Manufacturers Assn.* elected Henry M. Heyn to serve as president for the current year. He is sales manager of the Heat Treat Div. of Surface Combustion Corp.

Donald E. Babcock, metallurgical engineer for the Republic Steel Corp., was awarded the *American Iron & Steel Institute* Medal for his paper, presented at the Institute meeting in 1949. The medal is awarded for papers read before the Institute having special merit and importance in connection with the activities and interests of the iron and steel industry.

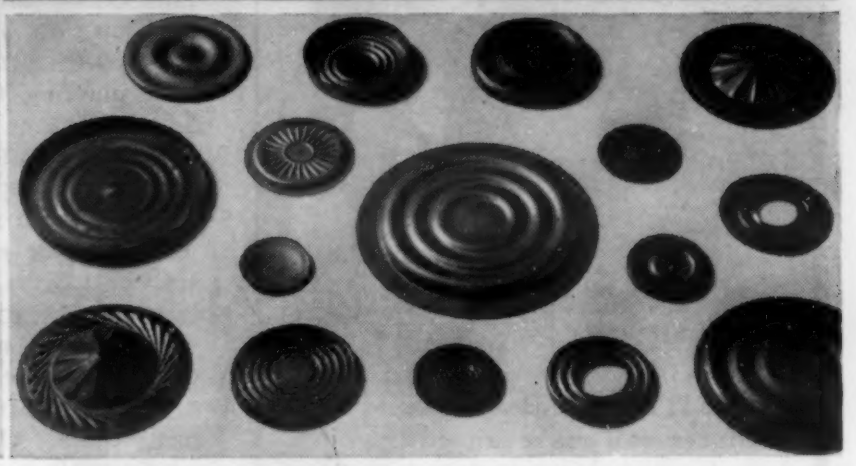
Your Product needs the unique properties of BERYLLIUM-COPPER!

SPRINGS



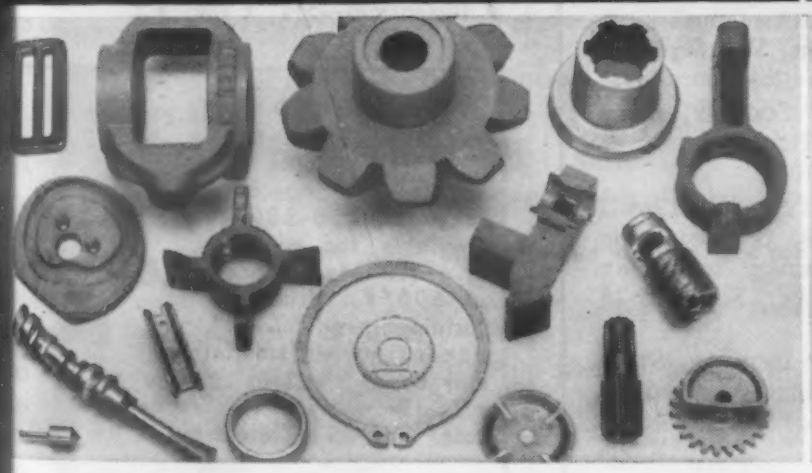
● Used in a wide range of parts, from delicate hairsprings to heavy switch members, beryllium-copper offers good corrosion and fatigue resistance, high elastic strength, excellent formability and dependable service at high or low temperatures. In current-carrying components including clips, connectors, sockets and terminals, it provides good electrical and thermal conductivity with high and constant contact pressure. Beryllium-copper is a standard material for instrument springs and similar critical applications requiring minimum drift, low hysteresis and close dimensional control. For more details write today for "Beryllium-Copper As a Spring Material."

PRESSURE RESPONSIVE ELEMENTS



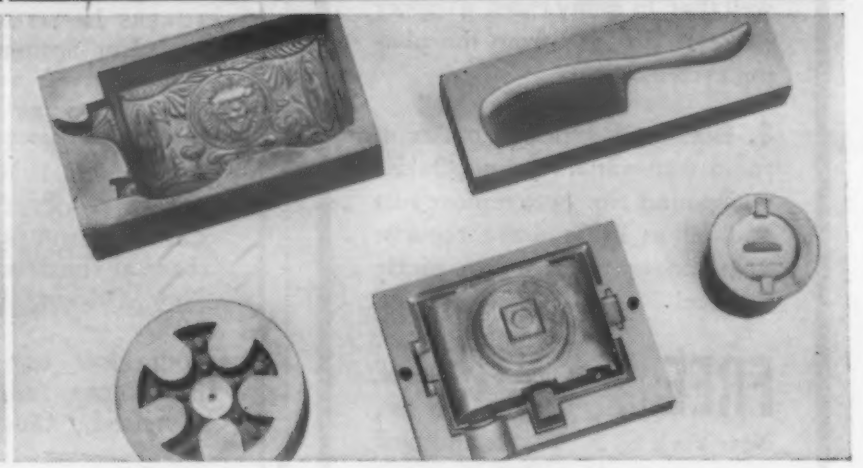
● Because of the above and other properties, beryllium-copper insures positive action, stability and accuracy in pressure responsive elements over long periods of time. High elastic strength means greatest space economy or widest working range with maximum sensitivity. These characteristics offer special advantages in designing diaphragms, bellows and bourdon tubes in devices for measuring and controlling temperature or pressure. Valuable data in this field is contained in "Production of Metal Diaphragms" —available upon request.

MECHANICAL PARTS



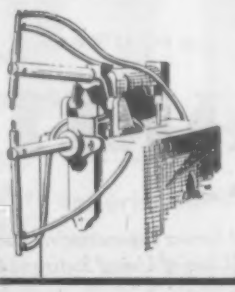
● Superior to other copper alloys in strength, hardness and wear resistance, beryllium-copper is widely used in such applications as retaining rings, shaft seals, spring washers, bushings, cams, bearings, gears, fasteners and valve parts. Wrought, forged or cast products can be readily machined or formed in the unhardened condition, then heat-treated to the desired properties by a simple, low-temperature treatment. Request "What Beryllium-Copper Offers The Designer" for additional information.

PLASTICS MOLDS



● Through excellent castability which minimizes machining, beryllium-copper finds increasing use in cavities and forces for the injection molding of plastics. In many instances, BERYLCO 275C molds produced by sand, investment and pressure casting methods give decreased operating and tooling costs over long or short runs. In addition to good compressive and impact strength, the relatively high thermal conductivity of this alloy insures substantially higher production rates than obtainable in steel molds. Write for "Cutting Costs With Beryllium-Copper Molds."

● ***RESISTANCE WELDING*** By virtue of high compressive strength, low surface contact resistance and good electrical and thermal conductivity, beryllium-copper alloys are also excellent resistant welding materials (RWMA Classes 3 & 4) for spot, seam, flash and projection welding dies and electrodes.



THE BERYLLIUM CORPORATION

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Meetings and Expositions

UNITED STATES INTERNATIONAL TRADE FAIR. Chicago, Ill. Aug. 7-19, 1950.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Los Angeles, Calif. Aug. 14-16, 1950.

NATIONAL ASSOCIATION OF POWER ENGINEERS, national power show. St. Louis, Mo. Aug. 14-18, 1950.

AMERICAN CHEMICAL SOCIETY, national meeting. Chicago, Ill. Sept. 3-8, 1950.

NATIONAL CHEMICAL EXPOSITION. Chicago, Ill. Sept. 5-9, 1950.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting. Milwaukee, Wis. Sept. 12-14, 1950.

NATIONAL PETROLEUM ASSOCIATION, annual meeting. Atlantic City, N. J. Sept. 13-15, 1950.

PORCELAIN ENAMEL INSTITUTE, annual forum. Urbana, Ill. Sept. 13-15, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. conference. Buffalo, N. Y. Sept. 18-22, 1950.

INSTRUMENT SOCIETY OF AMERICA, national instrument exhibit. Buffalo, N. Y. Sept. 18-22, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Worcester, Mass. Sept. 19-21, 1950.

ILLUMINATING ENGINEERING SOCIETY, national meeting. French Lick, Ind. Sept. 19-23, 1950.

PACKAGING MACHINERY MANUFACTURERS INSTITUTE, annual meeting. Hot Springs, Va. Sept. 23-26, 1950.

STEEL FOUNDERS' SOCIETY, annual fall meeting. Hot Springs, Va. Sept. 25-26, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, petroleum mechanical engineering conference. New Orleans, La. Sept. 25-28, 1950.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Cleveland, Ohio. Sept. 26-29, 1950.

INDUSTRIAL PACKAGING & MATERIALS HANDLING EXPOSITION. Philadelphia, Pa. Sept. 26-29, 1950.

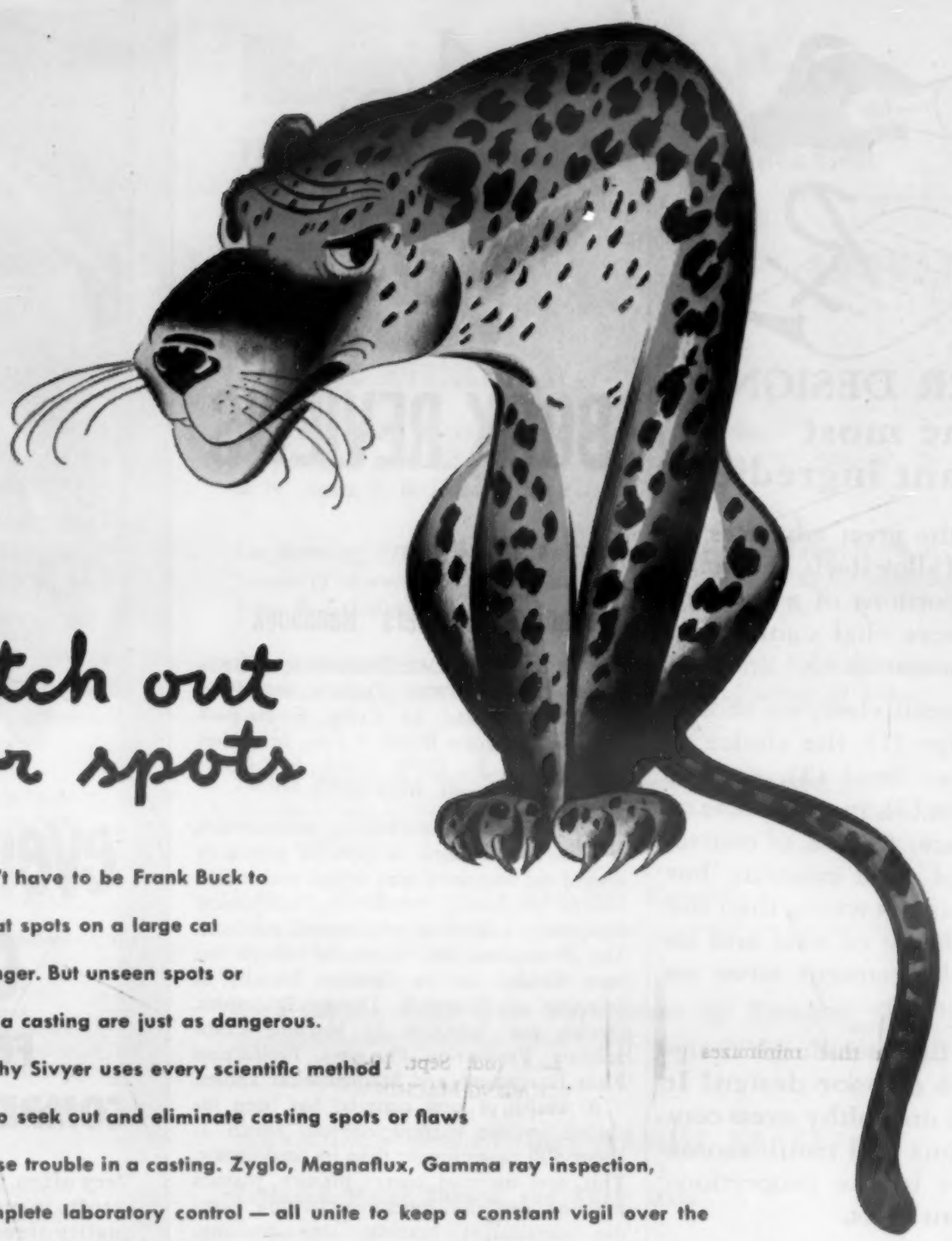
SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic and aircraft engineering display. Los Angeles, Calif. Sept. 27-30, 1950.

AMERICAN GAS ASSOCIATION, annual convention. Atlantic City, N. J. Oct. 2-6, 1950.

TEXAS MID-CONTINENT OIL & GAS ASSOCIATION, annual meeting. Dallas, Tex. Oct. 4-5, 1950.

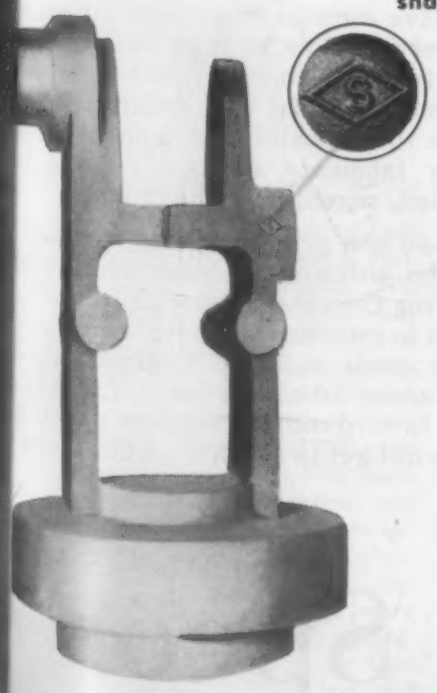
AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting. Chicago, Ill. Oct. 11-13, 1950.

ELECTROCHEMICAL SOCIETY, semi-annual meeting. Buffalo, N. Y. Oct. 11-14, 1950.



watch out for spots

You don't have to be Frank Buck to know that spots on a large cat spell danger. But unseen spots or flaws in a casting are just as dangerous. That's why Sivyer uses every scientific method known to seek out and eliminate casting spots or flaws that cause trouble in a casting. Zyglo, Magnaflux, Gamma ray inspection, plus complete laboratory control — all unite to keep a constant vigil over the development of a flawless casting, making sure that the integrity of the metal, the machined surface, and the precision shape of each casting can be pronounced safe — with the final stamp of the Sivyer Ⓢ.



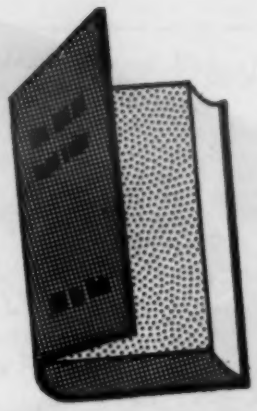
A spot that identifies better steel castings

You don't have to be an expert "tracker" to recognize the "sign" of a fine casting — it's there for all the world to see — the inimitable Sivyer Ⓢ.

SIVYER

SPECIALISTS IN HIGH ALLOY AND SPECIFICATION STEEL CASTINGS

SIVYER STEEL CASTING COMPANY • MILWAUKEE Ⓢ CHICAGO Ⓢ



BOOK REVIEWS

Mechanical Engineers' Handbook

KENT'S MECHANICAL ENGINEERS' HANDBOOK, 12TH EDITION. DESIGN AND PRODUCTION — *edited by Colin Carmichael. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1950. Cloth, 5⅞ in. by 8⅞ in., 1660 pages. Price $8.50.*

This half of the two-volume arrangement of Kent's Handbook is directed primarily toward the engineers who design and manufacture machinery, appliances, mechanical equipment and other engineered products. The 28 sections into which the volume has been divided can be classified broadly as Selection of Materials, Design Principles, Design and Selection of Machine Components, Production Processes, Production Plant Equipment, and Mathematical Tables.

A wealth of new material has been included in the current edition, which is about 300 pages longer than its predecessor. This new material covers plastics, plastics molding, precision investment casting, powder metallurgy, brazing, shot peening, statistical quality control, measurement and designation of surface quality, and other subjects.

The presentation of each subject has been planned to give the engineer a quick grasp of the essentials of the field, together with pertinent technical data in condensed form. These data consist of: basic principles; working formulas, charts and tables; standard dimensions, proportions and specifications; and illustrated discussions of typical equipment. References included in the text and at the ends of many of the chapters guide the reader to sources of more detailed information. In addition, a 49-page index makes it easy to locate specific subjects quickly.

Other New Books

RESISTANCE WELDING IN MASS PRODUCTION. *By A. W. Hipperson and T. Watson. Published by Iliffe & Sons, Ltd., London, England, 1950. Available in the United States from British Book Centre, Inc., New York 22, N. Y. Cloth, 5¾ by 8¾ in., 278 pages. Price $4.75.* This book is the outcome of a series of articles on resistance welding which were contributed to the magazine *Welding* mainly during the years 1947 and 1948, and deals principally with the resistance welding processes from the mass production aspect.